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ABSTRACT

This document contains the Northwest Regional Educational Laboratory's Test Center alternative assessment holdings for science which covers all grade levels. Alternative refers to holdings or topics other than standardized, norm-referenced tests. Included are 129 annotated state, classroom, national, and international assessments. Items are coded by type, purpose, grade level, content, type of task, skills assessed, and assessed, and type of scoring. (MKR)

Innovative Assessment

BIBLIOGRAPHY OF ASSESSMENT ALTERNATIVES:

SCIENCE

Fall 1995 Edition

Northwest Regional Educational Laboratory

THE TEST CENTER

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Innovative Assessment

Bibliography of Assessment Alternatives: SCIENCE

Fall 1995 Edition

The Test Center
Evaluation and Assessment Program
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BIBLIOGRAPHY OF ASSESSMENT ALTERNATIVES: SCIENCE

September 1995

Our goal is to assure that our citizens know enough about science so that they:

- can tell the difference between sense and nonsense, between science and pseudoscience
- can distinguish the possible from the impossible, the probable from the improbable
- can understand both the powers and limits of science and technology
- are not at the mercy of experts—or worse, of charlatans posing as experts
- can be participants, not victims, in our increasingly and irreversible technological society.

(David Saxon, Massachusetts Institute of Technology, February 17, 1991)

If you'd like to know what neat "goodies" are out there in the realm of alternative assessment, this is the document for you. We've collected hundreds of alternative assessment ideas in science that cover all grade levels. We include state assessments, classroom assessments, and national or international assessments. Most are very recent—some even published in 1995!

The following articles represent Test Center holdings to date in the area of assessment alternatives in science. Presence on the list does not necessarily imply endorsement; articles are included to stimulate thinking and provide ideas. By "alternative" we mean "other than standardized, norm-referenced." We include performance assessments, portfolios, technological innovations, etc. For more information, contact Matthew Whitaker, Test Center Clerk, at (503) 275-9582, Northwest Regional Educational Laboratory, 101 SW Main Street, Suite 500, Portland, Oregon 97204, e-mail: testcenter@nwrel.org. To purchase a copy of this bibliography, please call NWREL's Document Reproduction Service at (503) 275-9519.

Glossary: In this bibliography, terms are used in the following way: *open-response* = tasks with only one right answer; *open-ended* = having more than one right answer; *holistic rubric* = one score based on overall impression; *analytical trait rubric* = performance judged along several dimensions; *task specific rubric* = rubric tailored for a specific task; and *generalized rubric* = rubric used across tasks.

Abraham, Michael R., Eileen Bross Grzybowski, John W. Renner, et al. ***Understandings and Misunderstandings of Eighth Graders of Five Chemistry Concepts Found in Textbooks.*** **Located in:** **Journal of Research in Science Teaching 29, 1992, pp. 105-120.**

The study reported in this paper looked at how well grade eight students understand five concepts in chemistry chemical change, dissolution, conservation of atoms, periodicity, and phase-change. There are five problems, one associated with each concept. Each problem describes (and/or shows) a problem situation and asks one to three questions. Some questions require short answers and some require explanations of answers. Each response is scored on a six-point scale of conceptual understanding from "no response" to "sound understanding" of the concept. The paper gave some examples of misunderstandings shown by the students.

The authors found that very few students really understood the concepts. They speculate that this may either be due to the nature of instruction (mostly textbook driven and little hands-on) or because students are not developmentally ready for the formal logic found in these concepts. The paper also reports some information on student status and the relationship between scores on this test and another measure of formal logical thinking.

(TC#650.3UNDMIE)

Alberta Education. ***Evaluating Students' Learning and Communication Processes,*** **January 1993-January 1994. Available from: The Learning Resources Distributing Centre, 12360—142 St., Edmonton, AB T5L 4X9, Canada, (403) 427-2767, fax (403) 422-9750.**

The goals of the *Evaluating Students' Learning and Communication Processes* program are to: (1) evaluate progress of secondary students (grades 7-10) in six learning and communication processes; (2) integrate the six processes across classes in language arts, social studies, and science; and (3) empower students to take control of learning by making them conscious of the six process skills and how they, themselves, use them. It is based on the premise that students' achievement is directly related to the extent to which they have conscious, independent control over essential learning and communication processes. The six learning and communication processes are: exploring, narrating, imagining, empathizing (understanding the perspectives of others), abstracting (create, support, apply and evaluate generalizations), and monitoring. The materials provide generalized performance criteria (indicators) that serve both to define each process skill and to provide a mechanism for judging the quality of student use of the skill, regardless of the area in which they are working.

There is a general handbook for all subject areas that covers evaluation (performance criteria and recording information) and instruction (how to implement the program, instructional activities for students, help with student self-reflection, help with teacher collaboration, and how to report student progress). There is a separate handbook for each subject area that contains sample teaching units designed to show teachers how to incorporate diagnostic evaluation of students' learning and communication processes into regular instruction. In science the diagnostic teaching units are in the areas of structures/design for grade 7 and acids/bases for grade 10.

The documents give a good rationale for the importance of the six process skills and the importance of student self-monitoring of the processes. They also give extremely good advice on how to design instructional tasks that require students to use the six process skills, how to use instructional tasks as a context for student self-monitoring of process skills, and how to evaluate progress on these skills. The documents are also very useful because they have attempted to define process skills and apply them across subject matter areas. No technical information is provided. Some sample student work is provided.

(TC# 600.3EVASTL)

Appalachia Educational Laboratory. *Alternative Assessments in Math and Science: Moving Toward a Moving Target*, 1992. Available from: Appalachia Educational Laboratory, PO Box 1348, Charleston, WV 25325, (304) 347-0400.

This document reports a two-year study by the Virginia Education Association and the Appalachia Educational Laboratory which twenty-two K-12 science and math teachers designed and implemented new methods of evaluating student competence and application of knowledge. Teachers who participated in the study felt that the changes in assessment methods led to changes in their teaching methods, improvements in student learning and better student attitudes. Instruction became more integrated across subjects, instruction shifted from being teacher-driven to being student-driven, and teachers acted more as facilitators of learning rather than dispensers of information.

Included in the report is a list of recommendations for implementing alternative assessments, a list of criteria for effective assessment, and 22 sample activities (with objectives, tasks, and scoring guidelines) for elementary, middle, and high school students, all designed and tested by the teachers in the study.

Most activities have performance criteria that are holistic and task-specific. No technical information or sample student work is included.

(TC#600.3ALTASM)

Arter, Judith A. *Integrating Assessment and Instruction*, 1994. Available from: Northwest Regional Educational Laboratory, 101 SW Main St., Suite 500, Portland, OR 97204, (503) 275-9582, fax: (503) 275-9489.

Although not strictly about science assessment, this paper is included because of its discussion of how, if designed properly, performance assessments can be used as tools for learning in the classroom as well as tools for monitoring student progress.

(TC# 150.6INTASI)

Arter, Judith A. ***Performance Criteria: The Heart of the Matter*, 1994. Available from: Northwest Regional Educational Laboratory, 101 SW Main St., Suite 500, Portland, OR 97204, (503) 275-9582, fax: (503) 275-9489.**

Although not directly related to science assessment, this paper discusses an important issue that pertains to performance assessment in general—the need for clear and well thought out scoring mechanisms. The paper discusses what performance criteria are, the importance of good quality performance criteria, how to develop performance criteria, and keys to success. The author argues for generalized, analytical trait performance criteria that cover all important aspects of a performance and are descriptive.

(TC# 150.6PERCRH)

Aurora Public Schools. ***Performance Assessments in Science and Mathematics*, 1994. Available from: Strategic Plan Facilitator, Aurora Public Schools, Department of Instructional Services, 15751 E. 1st Ave., Suite 220, Aurora, CO 80011, (303) 340-0861, fax: (303) 340-0865.**

The author has provided three high school examples of the types of assessments being developed by teachers in Aurora Public Schools: developing an analogy for the major anatomical and physiological components of a typical eukaryotic cell, recommending a decision concerning the future use of a medical technology in human biology, and collecting and analyzing a data set. These examples include a description of the task, prerequisite student experiences, and criteria for judging student performance on the task. Students work in groups of two to four. The assessments are mostly for classroom use.

Performances are evaluated along several dimensions including content, complex thinking, decision making, and collaborative working. Most of the rubrics are task specific and emphasize relative quality. For example, a "4" score for complex thinking on the medical technology task is: "The student clearly and completely identified the criteria by which the alternatives were assessed. The criteria were presented in detail and reflected an unusually thorough understanding and concern for the repercussions of the decision." The collaborative worker rubric is generic and more descriptive; a "4" is "The student expressed ideas clearly and effectively; listened actively to the ideas of others; made a consistent effort to ensure that ideas were clearly and commonly understood; accurately analyzed verbal and non-verbal communications; solicited and showed respect for the opinions of others."

No technical information nor sample student responses are included.

(TC# 000.3SCIMAP)

Badger, Elizabeth and Brenda Thomas. ***On Their Own: Student Response to Open-Ended Tasks in Mathematics,*** **1989-91. Available from: The Commonwealth of Massachusetts, Massachusetts Department of Education, 350 Main St., Malden, MA 02148, (617) 388-3300.**

The materials we received contain assessment materials for grades 4, 8 and 12 from three years (1988-1990) in four subject areas: science, math, social studies and reading. This entry describes the science portion of the materials.

In the 1988 and 1990 materials, students were given a written problem in which they had to apply concepts of experimental design, or use concepts in life or physical sciences, to explain a phenomenon. All problems are included in this document. Responses were analyzed for the ability to note important aspects of designing an experiment or the amount of understanding of concepts they displayed. No specific performance criteria or scoring procedures are provided. However, there is extensive discussion of what students did, illustrated by sample responses. Because some of the information was also presented in multiple-choice format, the state was able to conclude that "although students appear to know and recognize the rules and principles of scientific inquiry when presented as stated options, unstructured situations that demand an application of these principles seem to baffle them."

In 1989, a sample of 2,000 students was assigned one of seven performance tasks (the three in science required lab equipment and/or manipulatives) to do in pairs. Each pair was individually watched by an evaluator. It took 65 evaluators five days to observe the 2,000 performances. Evaluators were to both check off those things that students did correctly (e.g., measured temperature correctly), and record observations of students' conversations and strategies. Again, detailed scoring procedures are not provided. There is, again, much discussion of observations illustrated by samples of student responses.

Some information about results for all the assessments is provided: percentages of students getting correct answers, using various strategies, using efficient methods, giving good explanations, etc., depending on the task. No technical information about the tests themselves is provided.

(TC#600.3ONTHOS)

Baker, Eva L., Pamela R. Aschbacher, David Niemi, et al. ***CRESST Performance Assessment Models: Assessing Content Area Explanations,*** **April 1992. Available from: National Center for Research on Evaluation, Standards, and Student Testing (CRESST), Center for the Study of Evaluation, UCLA Graduate School of Education, 145 Moore Hall, Los Angeles, CA 90024, (310) 206-1532, fax (310) 825-3883.**

The authors provide two detailed examples of performance assessments for high school students—history and chemistry. In addition to these two specific examples, the document includes help on duplicating the technique with other subject matter areas, including rater training, scoring techniques, and methods for reporting results. The general assessment procedure includes: a Prior Knowledge Measure which assesses (and activates) students' general and topic-relevant knowledge; provision of primary-source/written-background materials; a writing task in which students integrate prior and new knowledge to explain subject matter issues in responses to prompts; and a scoring rubric.

The prior knowledge portion of the chemistry example consists of 20 chemistry terms for which students "write down what comes to mind drawing upon [their] knowledge of chemistry." The "written materials" consist of a description of how a chemistry teacher tests samples of soda pop to determine which contained sugar and which contained an artificial sweetener. The writing task involves assisting a student who has been absent to prepare for an exam.

Scoring is done on a scale of 0-5 for each of: overall impression, prior knowledge, number of principles or concepts cited, quality of argumentation, amount of text-based detail, and number of misconceptions. (The scoring scheme is elaborated upon for the history example, but not for the chemistry example.) Scoring on several of the five-point scales is based on the number of instances of a response rather than their quality. For example, conceptual misunderstanding is scored by counting the number of misunderstandings. Only the "argumentation" scale calls for a strictly quality judgment.

No technical information is included. Sample student responses are provided for the history example but not the chemistry example.

(TC# 000.3CREPEA)

Barnes, Lehman W., and Marianne B. Barnes. *Assessment, Practically Speaking*. Located in: Science and Children, March 1991, pp. 14- 15.

The authors describe the rationale for performance assessment in science. Traditional tests (vocabulary, labeling, matching, multiple-choice, short-answer, puzzle, questions, essay) accurately assess student mastery of the verbal aspects of science, but they do not allow students to demonstrate what they know.

(TC#600.6ASSPRS)

Baron, Joan B. *Performance Assessment: Blurring the Edges Among Assessment, Curriculum, and Instruction*, 1990. Located in: Champagne, Lovitts and Calinger (Eds.), Assessment in the Service of Instruction, 1990, pp. 127-148. Available from: American Association for the Advancement of Science, 1333 H St. NW, Washington, DC 20005, [AAAS Books: (301) 645-5643]. Also in: G. Kulm & S. Malcom (Eds.), Science Assessment in the Service of Reform, 1991, pp. 247-266, AAAS.

After a brief discussion of the rationale for doing performance assessments in science, this article describes work being done in Connecticut as of 1991. Therefore, although the former is still relevant, the latter has been updated by other entries in this bib.

(TC#600.6PERASB)

Bennett, Dorothy. ***Assessment & Technology Videotape,*** **1993. Available from: The Center for Technology in Education, EDC, 96 Morton St., , New York, NY 10014, (212) 807-4200.**

The Center for Technology in Education (CTE) has been conducting research on how best to use technology in assessment. It supports the use of video to capture aspects of students' performance that cannot be assessed with paper and pencil.

This document consists of a video and handbook that focus on the assessment of thinking skills, communication skills and interpersonal skills. Its context is a group project which requires applying physics to the design of motorized devices. The first part of the video describes an alternative assessment system that uses students' personal journals, group logs, projects, and presentations. The group projects and presentations are the major part of the assessment. Presentations are videotaped and scored by a panel of experts and other students. The second part of the video contains four examples of students' presentations (car wash, tank, garbage truck, oscillating fan) which can be used to practice scoring using the criteria in the handbook. Performances are scored using generalized criteria for thinking skills, communication/presentation skills, and work management/interpersonal skills, by looking at the relative numbers of positive and negative instances of each behavior.

Brief descriptions of the above criteria are contained in the handbook. The procedure is a prototype. Feedback by those attempting to use the criteria is requested.

(TC#600.3ASSTEVh and 600.3ASSTEVv)

Berenson, Sarah B. and Glenda S. Carter. ***Writing Open-Ended Science Problems.*** **Located in: <u>Science Educator</u> 3, Spring 1994, pp. 23-26. Available from: National Science Supervisors Assn., Glastonbury Public Schools, 330 Hubbard St., Glastonbury, CT 06033, (516) 267-3692**

In this article the authors describe how to develop open-ended questions in science. The procedure was developed through work with grade 3-8 math and science teachers in Granville, North Carolina, to develop assessments for the classroom. The article provides examples of open-ended items that ask students to write stories, to offer opinions, to write descriptions, and to teach science concepts to others. No rubrics are provided. However, the article discusses how teachers might develop expertise in developing rubrics for these open-ended items.

(TC# 600.6WRIOPE)

British Columbia Ministry of Education. ***Performance Assessment: Primary, Early, Late, Intermediate, and Graduate,*** **Draft, August 1992. Available from: Ministry of Education, Assessment Branch, Victoria, British Columbia.**

This is a Macintosh disk containing a host of performance assessments developed by the British Columbia Ministry of Education for all grade levels and subject matter areas.

(TC# 000.3BCPERA)

California Assessment Collaborative. ***Charting the Course Toward Instructionally Sound Assessment—A Report of the Alternative Assessment Pilot Project,*** **September 1993. Available from: California Assessment Collaborative, 730 Harrison St., San Francisco, CA 94107, (415) 241-2704.**

The California Assessment Collaborative was designed as a three-year effort to systematically identify, validate, and disseminate alternatives to standardized testing. This report presents findings from the first year for 22 pilot projects including costs, impacts, and recommendations about future work.

The book does an excellent job of placing assessment change into the context of restructuring. It discusses how the following fit together: articulating content standards, monitoring student progress toward goals, building teacher capacity to assess, building student capacity to self-assess, student outcomes, curriculum, and instruction.

(TC# 150.6CHACOU)

California Department of Education. ***Facilitators Guide to Science Assessment,*** **Spring 1995. Available from: California Department of Education, PO Box 944272, Sacramento, CA 94244, (916) 657-2451, fax: (916) 657-5101.**

The *Facilitator's Guide to Science Assessment* was developed by teachers, trainers, and CLAS to:

- Provide teachers with two professional development modules for assisting teachers to better understand and implement authentic assessment in science
- Show the connections among assessment, curriculum, and instruction
- Prepare teachers to develop, administer, and score authentic assessments in their classrooms and to communicate student achievement to students, parents, and other educators
- Highlight the systemic nature of science education reform in California

Phase I is a two-day training that provides teachers new to science assessment with an understanding of the links between quality instruction and authentic assessment, and then provides opportunities to experience and score performance assessment and plan for implementation in their classrooms. Be cautious of the activity Phase I, Part E: Scoring. The authors use specialized definitions for various types of scoring guides that may be confusing to those using other definitions.

All needed materials (presenter's outline, handouts, hard copy of overheads) for the two training modules are included.

Phase II is a three-day training that provides teachers experienced with authentic assessment an opportunity to develop and field test their own classroom performance assessment tasks and scoring guides (rubrics) linked to the "big ideas" in the *California Science Framework*.

The guide has excellent sections on (1) comparing multiple choice and performance assessments (including sample performance tasks for elementary, middle, and high school), (2) relating performance assessment to the "big ideas" in science, and (3) designing performance tasks.

(TC# 600.6SCIASS)

California Department of Education. *Golden State Examination Biology and Chemistry*, 1993. Available from: California Department of Education, PO Box 944272, Sacramento, CA 94244, (916) 657-2451, fax: (916) 657-5101

The purpose of the Golden State Examination is to identify and recognize students with outstanding achievement in biology, algebra, geometry, US history, chemistry, and economics. This document describes the 1993 assessments.

There are two required sections taking 45 minutes each. The first section is multiple-choice, justified multiple-choice, and short answer. The second section is a laboratory task, performed individually by using materials at testing stations.

Results are scored using a generic 1-6 point scale tailored to specific tasks. The generic scoring guide emphasizes knowledge of biological concepts, creative use of principles, relevant alternative explanations, sound analysis of data, and clear communication.

The open-ended and laboratory tasks are scored using a generic, six-point holistic rubric that is tailored to individual questions. The scoring is based on content knowledge, science process skills, logical thinking, and clear communication. Sample tasks and student responses are included. No technical information is included.

(TC#600.3GOLSTB)

California Department of Education. ***Golden State Examination Science Portfolio—Guide for Teachers and Students*, 1994-95. Available from: California Department of Education, 721 Capital Mall, Sacramento, CA 94244.**

The GSE *Science Portfolio* is an optional part of California's Golden State Examination, an assessment system designed to place an academic endorsement on students' high school diplomas. Endorsements are available in science, social studies, and language arts. The *Science Portfolio* score is added to the scores on the other portions of the assessment system (multiple choice, short answer, essay, and laboratory), if it improves overall performance.

The *Science Portfolio* is developed during a year of high school biology, chemistry, or integrated science. Content must include a self-generated, problem-solving investigation; a creative expression (expressing a concept in science in an alternative way that enhances meaning, e.g., art, music, writing); and "learning by writing" (a series of pieces that demonstrates growth in understanding). Each of the three pieces includes a cover page that asks students why the piece was chosen and requires students to self-reflect on the development process.

Each of the three entries (together with the cover page) is scored with a separate holistic (one score) rubric based on such things as conceptual understanding, group collaboration, and quality of communication. There is also a rubric for scoring the portfolio as a whole. Some technical information is included. Contact the authors for samples of student work.

(TC# 600.3GOLSTE2)

California Department of Education. *Science—New Directions in Assessment, California Learning Assessment System*, 1993. Available from: California Department of Education, PO Box 944272, Sacramento, CA 94244, (916) 657-2451, fax: (916) 657-5101

This document contains the following: five performance tasks (1991 pilot performance tasks for grades 8, and 11, and 1992 performance tasks for grades 5, 8, and 10); a newsletter describing current status of the science portfolio for grades 5, 8, and 10; and an overview of the California Learning Assessment System (CLAS) for 1990-1992. (The CLAS also has an enhanced multiple-choice section that is described, but not illustrated, in this document.)

The tasks require some individual and some group work, have multiple questions focusing on a common theme (e.g., recycling or fossils), and require several class periods to complete. Scoring on the tasks in grades 5 and 8 is task specific (on a scale of 0-4 or 0-6); scoring on the grade 10 and 11 tasks uses a general 1-4 point scoring guide that emphasizes understanding, detailed observations, good quality data, good experimental design, organized presentation of data, supported conclusions, and reasonable explanations.

Neither technical information nor sample student responses are included.

(TC#600.3SCINED)

Center for Talent Development. ***Elementary School Pre-Post Survey*** **and** ***Middle/High School Pre-Post Survey*****, 1993. Available from: Evaluation Coordinator, Center for Talent Development, Northwestern University, Andersen Hall, 2003 Sheridan Rd., Evanston, IL 60208, (708) 491-4979.**

This document contains surveys of student attitudes toward mathematics and science. There are two levels—elementary and middle/high school. It was designed for use with Access 2000 participants who are primarily African-American and Hispanic students in an inner-city public school system and enrolled in a math/science/engineering enrichment program.

(TC# 220.3QUEELM)

Champagne, Audrey, B. Lovitts, and B. Calinger. ***Assessment in the Service of Instruction*****, 1990. Available from: American Association for the Advancement of Science, 1333 H St. NW, Washington, DC 20005 [AAAS Books: (301) 645-5643].**

This book is a compilation of eleven papers that address the issue of making assessment a tool for meaningful reform of school science. The book contains papers that cover: an overview of good assessment, national and state assessment initiatives, traditional assessments, innovative assessments (performance, group, portfolio, and dynamic), and experiences in England and Wales.

The introductory article by two of the editors *(Assessment and Instruction: Two Sides of the Same Coin)* covers the following topics:

1. Reasons for assessing, including instruction, conveying expectations, monitoring achievement, accountability and program improvement.

2. What should be assessed, and the inability of multiple-choice tests to assess the most important aspects of scientific competence: generating and testing hypotheses, designing and conducting experiments, solving multi-step problems, recording observations, structuring arguments, and communicating results; or scientific attitudes—comfort with ambiguity and acceptance of the tentative nature of science.

3. A definition of "authentic" assessment: "An assessment is authentic only if it asks students to demonstrate knowledge and skills characteristic of a practicing scientist or of the scientifically literate citizen." Simply matching the curriculum is not enough, because the curriculum may be lacking.

Other articles from this book that are particularly relevant to this bibliography are described separately.

(TC#600.6ASSINT)

Chi, M.T., P.J. Feltovich, and R. Glaser. ***Categorization and Representation of Physics Problems by Experts and Novices.*** **Located in: <u>Cognitive Science</u> 5, 1981, pp. 121-152.**

The authors report on a series of studies to determine the differences between expert and novice problem solvers in physics. Although this paper is not about assessment per se, the observations in the paper might help users to define what good physics problem solving looks like, which in turn can serve as the basis for forming performance criteria to be used with performance assessments. Several samples of expert and novice thinking are provided.

(TC#660.6CATREP)

Clarridge, Pamela Brown, and Elizabeth M. Whitaker. ***Implementing a New Elementary Progress Report.*** **Located in: <u>Educational Leadership</u>, October 1994, pp. 7-9. Also available from: Tucson Unified School District #1, 1010 E. Tenth St., Tucson, AZ 85719.**

This paper reports on one district's attempt to revise its report card for grades K-5 using a rubric approach. In grades 1-5, rubrics using four-point scales were developed for five "learner qualities"—self-directed learner, collaborative worker, problem solver, responsible citizen, and quality producer—and eight content areas—reading, writing, listening/speaking, mathematics, social studies, science, health, and fine arts. Room is provided on the report card for teacher comments, the basis for judgments about student ability (e.g., classroom observation, portfolios), and teacher/student comments.

The authors describe development and pilot testing, preliminary responses from parents and students, plans for revision, and insights (such as "this approach to reporting requires a thorough understanding of the curriculum by both parents and teachers").

(TC# 150.6IMPNEE)

Coalition of Essential Schools. Various articles on exhibitions of mastery and setting standards, 1982-1992. Available from: Coalition of Essential Schools, Brown University, Box 1969, One Davol Sq., Providence, RI 02912, (401) 863-3384.

Although not strictly about science, this series of articles is useful in general because they discuss the following topics: good assessment tasks to give students, the need for good performance criteria, the need to have clear targets for students that are then translated into instruction and assessment, definition and examples of performance assessments, brief descriptions of some cross-disciplinary tasks, the value in planning performance assessments, and the notion of planning backwards (creating a vision for a high school graduate, taking stock of current efforts to fulfill this vision, and then planning backward throughout K-12 to make sure that we are getting students ready from the start).

(TC#150.6VARARD)

Collins, Allan, Jan Hawkins, and John R. Frederiksen. ***Three Different Views of Students: The Role of Technology in Assessing Student Performance, Technical Report No. 12,*** **April 1991. Available from: Center for Technology in Education, Bank Street College of Education, 610 W. 112th St., New York, NY 10025, (212) 875-4550, fax: (212) 316-7026. Also available from ERIC: ED 337 150.**

This paper begins by discussing why assessment in science needs to change: if tests continue to emphasize facts and limited applications of facts the curriculum will be narrowed to these goals. The paper then gives several good examples of how high-stakes uses of tests have negative, unintended side effects on curriculum and instruction.

The authors use the term "systemically valid" to refer to assessments that are designed to create the learning they also assess. The authors discuss four criteria for "systemically valid" tests: (1) the test directly measures the attribute of interest, (2) all relevant attributes are assessed, (3) there is high reliability, and (4) those being assessed understand the criteria. They also discuss criteria for quality tasks, examples of alternative assessment ideas, cost, cheating, and privacy.

(TC#600.6THRDIV)

Collins, Angelo. ***Portfolios for Science Education: Issues in Purpose, Structure, and Authenticity.*** **Located in <u>Science Education</u> 76, 1992, pp. 451-463.**

The author teaches preservice science teachers. This paper discusses design considerations for portfolios in science and applies these considerations to portfolios for student science teachers, practicing science teachers, and elementary students. The design considerations the author suggests are:

1. Determine what the portfolio should be evidence of, i.e., what will the portfolio be used to show?

2. Determine what types of displays should go in the portfolio to provide evidence of #1. The author suggests and describes several types: artifacts (actual work produced), reproductions of events (e.g., photos, videotapes), attestations (documents about the work of the person prepared by someone else), and productions (documents prepared especially for the portfolio such as self-reflections).

3. View the portfolio as a "collection of evidence" that is used to build the case for what is to be shown. Those developing the portfolio should determine the story to be told (based on all the evidence available) and then lay this out in the portfolio so that it is clear that the story told is the correct one.

(TC#600.6PORSCE)

Comfort, Kathy. ***A Sampler of Science Assessment—Elementary*****, Preliminary Edition, January 1994. Available from: Publications Sales, California Department of Education, PO Box 271, Sacramento, CA 95802.**

Since 1989, the California Learning Assessment System (CLAS) has been developing, piloting, and field testing a range of new assessments in science, including performance tasks, enhanced multiple-choice items, open-ended and justified multiple-choice questions, and portfolios. These assessments are designed to provide students the opportunity to demonstrate conceptual understanding of the big ideas of science, to use scientific tools and processes, and to apply understanding of these big ideas to solve new problems.

In "performance tasks," students are provided with hands-on equipment and materials and are asked to perform short experiments, make scientific observations, generate and record their data, and analyze their results. "Open-ended questions" require students to respond by writing a short paragraph, drawing a picture, or manipulating data on a chart or a graph. "Enhanced multiple-choice" items require students to think through the big ideas of science. In justified multiple-choice questions, students may justify or briefly write why they chose their answer. The 1994 grade 5 assessment consisted of three components (8 enhanced and 2 justified multiple-choice items, and a performance assessment).

Scoring occurs in a variety of fashions. For example, the 1994 grade 5 assessment was scored using a four-point, holistic guide for the open-ended questions and a "component guide" for the performance tasks, in which similar items on a task are grouped and scored together. CLAS is also investigating the use of portfolios in science. Samples of student work are included.

(TC# 600.3SAMSCA)

Conley, David T., and Christine A. Tell. ***Proficiency-Based Admission Standards*****, January 8, 1995. Available from: PASS Project, Oregon State System of Higher Education, Office of Academic Affairs, PO Box 3175, Eugene, OR 97403, (503) 346-5799.**

This paper describes the Oregon Board of Higher Education's new policy on admitting students by demonstration of competencies rather than number of courses taken or GPA. Included is the rationale for the approach (including the incongruity between traditional college admissions procedures and the attempt by K-12 schools to restructure), a list of the competencies, ideas for assessment, ideas for how high schools might need to change in order to ensure students meet admissions standards, and commonly asked questions. Competencies include content standards for subject areas (science, math, etc.), as well as basic and process skills standards (writing, reading, critical thinking, etc.).

The paper addresses the concern that needed changes in K-12 education will be harder if students are still admitted to college using traditional methods. The authors point out that similar changes in college admissions policy are occurring in many places.

(TC# 150.6PROBAA)

Connecticut State Department of Education. ***Connecticut Common Core of Learning Assessment,*** **1989-1992. Available from: Connecticut State Department of Education, Division of Research, Evaluation, and Assessment, 165 Capitol Ave., Room 340, Hartford, CT 06106, (203) 566-4001.**

This package contains a variety of documents produced between 1989 and 1992. Included is information about: rationale for the assessment, Connecticut's Common Core of Learning (student learning objectives), development process, several sample tasks and scoring mechanisms, student and teacher feedback forms, summaries of student and teacher feedback on the assessments using these forms, a process for developing performance tasks, a survey for student attitudes about science and mathematics, and an example of concept mapping as an assessment tool.

There appear to be two kinds of tasks: complex group projects and shorter on-demand tasks covering individual skills. The projects attempt to get at application and extension of knowledge and concepts. They require some individual and some group work and extend over several days. The on-demand portion covers knowledge and its application in limited situations. Performances are scored for group collaboration, process skills, and communication skills. Some of the rubrics are task specific and some are general; some are based on quantity (the number of possible solutions listed, for example) and some are based more on quality.

(TC#000.3CONCOC)

Council of Chief State School Officers. ***The Collaborative Development of Science Assessments: The SCASS Experience,*** **June 1995. Available from: Rolf K. Blank, Director, Education Indicators Program, CCSSO/SEAC, One Massachusetts Ave. NW, Suite 700, Washington, DC 20001.**

This document describes the efforts of a consortium of 14 states to develop assessments in science, including: multiple-choice, short answer, extended response, performance tasks and portfolios. For middle school students there are:

- **Modules** which consist of a scenario (a set-up or passage) followed by six related selected response questions, one short answer question, and one extended response question.

- **Performance events** designed as kit-based activities to be done by small groups of students in a single class period. Some performance events are wet labs while others are paper-and-pencil projects.

- **Performance tasks** designed as individual student projects that occur outside of the classroom setting with some classroom time used in support. These tasks should take place over several weeks.

Example of each type is included in the document. The document does not discuss how performance on these tasks is scored.

The portfolio (designed for grades 4, 8, and 10) contains four types of entries:

1. **Experimental research entry** that shows students (a) understand how scientists work, (b) understand and use the scientific method, and (c) use habits of mind similar to those of a scientist.

2. **Non-experimental research entry** that illustrates the kind of research citizens might do in investigating an issue of personal or societal significance and making a decision.

3. **Creative entry** that asks students to communicate a scientific concept using any creative mode of the student's choosing.

4. **Written entry** that is a critique or persuasive piece.

Additionally, students are asked to reflect on the work illustrated through the other four entries in the portfolio. Criteria were developed for the portfolios, but they are not included in this document.

The document also discusses staff development, opportunity to learn, and includes surveys for students and teachers that ask about classroom structure, content, and approach.

(TC# 600.3COLDES)

CTB McGraw-Hill. ***CAT/5 Performance Assessment Supplement*****, 1990. Available from: CTB/McGraw-Hill, PO Box 150, Monterey, CA 93942, (800) 538-9547, fax (800) 282-0266.**

The "CTB Performance Assessments" are designed to either be stand-alone or integrated with the CAT/5 or CTBS/4. There are five levels for grades 2-11. The total battery includes reading/language arts, mathematics, science, and social studies. There are 12-25 short-response questions for each subtest. The math and science subtests take 30-40 minutes. The entire battery takes two to three hours. (For the CAT/5 there is a checklist of skills that can be used at grades K and 1.)

Some questions are grouped around a common theme. Many resemble multiple-choice questions with the choices taken off. For example, questions on one level include: "What are two ways that recycling paper products helps the environment?" "This table shows the air temperatures recorded every two hours from noon to midnight...At what time did the temperature shown on the thermometer most likely occur?" and "These pictures show some of the instruments that are used in science...List two physical properties of the water in the jar below that can be measured with the instruments shown in the pictures. Next to each property, write the name of the instrument or instruments used to measure the property."

Some of the answers are scored right/wrong and some are scored holistically. The materials we received contained no examples of the holistic scoring so we are unable to describe it. Scoring can be done either locally or by the publisher. When the Performance Assessments are given with the CAT/5 or CTBS/4, results can be integrated to provide normative information and scores in six areas. There are only three, however, that use the math and science subtests: demonstrating content and concept knowledge, demonstrating knowledge of processes/skills/procedures, and using applications/problem solving strategies. When the Performance Assessments are given by themselves only skill scores are available.

The materials we received contain sample administration and test booklets only. No technical information or scoring guides are included.

(TC# 060.3CAT5PA)

Curriculum Corporation. *Science—A Curriculum Profile for Australian Schools* and *Using the Science Profile*, 1994. Available from: Curriculum Corporation, St. Nicholas Pl., 141 Rathdowne St., Carlton, Victoria, 3053, Australia, (03) 639-0699, fax (03) 639-1616.

These documents represent the science portion of a series of publications designed to reconfigure instruction and assessment in Australian schools. The project, begun in 1989, was a joint effort by the States, Territories, and the Commonwealth of Australia, initiated by the Australian Education Council. The profiles are not performance assessments, per se, in which students are given predeveloped tasks. Rather, the emphasis has been on conceptualizing major student outcomes in each area and articulating student development toward these goals using a series of developmental continuums. These continuums are then used to track progress and are overlaid on whatever tasks and work individual teachers give to students.

The science profiles cover the strands of: earth and beyond, energy and change, life and living, natural and processes materials, and working scientifically. Each strand is divided into subareas called "organizers." For example, the organizers for the strand of "working scientifically" are: planning investigations, conducting investigations, processing data, evaluating findings, using science, and acting responsibly. Each organizer is tracked through eight levels of development. For example, the organizer "processing data" has "talks about observations and suggests possible interpretations" at Level 1, and "demonstrates rigour in handling of data" at Level 8.

There are lots of support materials that describe what each strand means, how to organize instruction, types of activities to use with students, and how to use the profiles to track progress. Some samples of student work are included to illustrate development. The documents say that the levels have been "validated," but this information is not included in the materials we received.

(TC# 600.3SCICUA)

Curriculum Corporation. ***Technology—A Curriculum Profile for Australian Schools*, 1994. Available from: Curriculum Corporation, St. Nicholas Pl., 141 Rathdowne St., Carlton, Victoria, 3053, Australia, (03) 639-0699, fax (03) 639-1616.**

This document represents the technology portion of a series of publications designed to reconfigure instruction and assessment in Australian schools. The project, begun in 1989, was a joint effort by the States, Territories, and the Commonwealth of Australia, initiated by the Australian Education Council. The profiles are not performance assessments, per se, in which students are given predeveloped tasks. Rather, the emphasis has been on conceptualizing major student outcomes in each area and articulating student development toward these goals using a series of developmental continuums. These continuums are then used to track progress and are overlaid on whatever tasks and work individual teachers give to students.

The technology profiles cover the major strands of: designing, making and appraising, information, materials, and systems. Each strand is broken down into subareas called "organizers." For example, the organizers for "designing, making and appraising" are investigating, devising, producing, and evaluating. Each organizer is tracked through eight levels of development. For example, "evaluating" goes from "describes feelings about own design ideas, products, and processes" at Level 1 to "analyzes own products and processes to evaluate the effectiveness of methodologies used and the short and longer-term impact on particular environments and cultures" at Level 8.

There are lots of support materials that describe what each strand means, how to organize instruction, types of activities to use with students, and how to use the profiles to track progress. Samples of student work are included to illustrate development. The document says that the levels have been "validated," but this information is not included in the materials we received.

(TC# 600.3TECCUA)

Doolittle, Allen E. ***The Cost of Performance Assessment in Science: The SCASS Perspective*, 1995. Available from: American College Testing, 2201 N. Dodge St., PO Box 168, Iowa City, IA 52243, (319) 337-1086, fax (319) 339-3021.**

The author makes estimates ranging from $11 to $14 per student to conduct a hands-on performance assessment in science. For his estimates, the author used performance tasks being developed by the State Collaborative on Assessment and Student Standards (SCASS) that were hands-on and took 30-55 minutes to administer. Estimates included development, administration, and scoring costs.

(TC# 600.6COSPES)

Doran, Rodney, Joan Boorman, Fred Chan, et al. *Assessment of Laboratory Skills in High School Science*, 1991. Available from: Graduate School of Education, University of New York at Buffalo, Buffalo, NY 14260, (716) 645-2455.

This document consists of four manuals (*Biology, General Science, Chemistry, and Physics*), and two overview presentations (*Alternative Assessment of High School Laboratory Skills* and *Assessment of Laboratory Skills in High School Science*). These describe a series of on-demand activities to assess high school student laboratory skills in science, and a study examining test reliability, inter-rater agreement, and correlations between different parts of the tests.

Six hands-on tasks are presented in each content area manual (biology, chemistry, physics). Each task has two parts. In Part A, students are given a problem to solve and are directed to state an appropriate hypothesis, develop a procedure for gathering relevant observations or data and propose a method for organizing the information collected. After 30 minutes their plans are collected. Plans are scored on three experimental design traits: statement of hypothesis, procedure for investigation, and plan for recording and organizing observations/data. In Part B students are given a predeveloped plan to collect information on the same questions as in Part A. They have 50 minutes to carry out the plan and compose a written conclusion. Performance on Part B is scored for quality of the observations/data, graph, calculations, and conclusion. This procedure ensures that success on Part B is not dependent on Part A. Scoring is designed to be generic: the same criteria are used across tasks. Individual ta..ks also have specific additional criteria.

The *General Science* test has six tasks set up in stations. Students spend ten minutes at each station. Students answer specific questions that are classified as planning, performing, or reasoning. Scoring is not generalized; points are awarded for specific answers.

All manuals include complete instructions for administering and scoring the tests. Only a few sample student responses are provided. Results from a study done with 32 high schools in Ohio showed that rater agreement was good, it was a very time-consuming process, and teacher reactions varied widely.

(TC#600.3ASSLAS)

Druker, Stephen L., and Richard J. Shavelson. ***Effects of Performance Assessment and Two Other State Policy Instruments on Elementary School Teachers' Implementation of Science Reform Goals.*** **Available from: University of California, Santa Barbara, Graduate School of Education, Santa Barbara, CA 93106.**

The authors studied the impact on four elementary school teachers of (a) *The Science Framework for California Public Schools*, the central document of the science reform movement in California; (b) the California Science Implementation Network (CSIN), an organization intended to train teachers to implement the framework's goals for hands-on science teaching in their schools; and (c) the pilot phase of the California Assessment Program's (CAP) statewide performance-based assessment in science which has been mandated by the state to assess the goals of the framework.

These teachers were interviewed several times, classroom materials were reviewed (quizzes, tests, curriculum, instructional materials, and worksheets), and teachers were observed during instruction. Conclusions are:

- Reformers may hold unrealistic goals for performance assessment and curriculum frameworks. For example, the expectation that performance assessment will highlight exemplary teaching for teachers fails to recognize that teachers' perspectives will influence what parts of the testing situation they will choose to model.

- Large differences in how teachers were influenced by the curriculum frameworks and performance assessments were observed.

- The teachers who will use information in the manner that the reform intends are those who already have beliefs about teaching and learning which are aligned with reform.

- Putting performance assessments in place, articulating systemwide plans, and providing model curriculums may not be sufficient to change teachers basic beliefs and practices. Given the complexity of this task, professional development needs to provide teachers with more opportunities to explore, confront, and change their current belief systems and to actively struggle with issues of how to implement reform goals in their classrooms.

(TC# 600.6EFFPEA)

Educational Testing Service. ***Miscellaneous alternative assessments,*** **1993. Available from: Educational Testing Service, 1979 Lakeside Pkwy, Suite 400, Tucker, GA 30084, (404) 723-7424.**

Six teams of elementary and middle schools in Georgia, in conjunction with the ETS Southern Field Office in Atlanta, are working on math and science assessment activities (cooperative group, videotape, open-ended experiments) that can be used across grades and content areas, and that are designed to assess science process skills, math problem solving, ability to communicate in science and math, and content knowledge.

The materials we have include scoring guides (both general and task-specific, and holistic and analytical trait) and scored samples of student work. No technical nor contextual information is included in the materials (although such information is available from the publisher). Any use requires permission from Educational Testing Service.

(TC# 000.3MISALA)

Everett, Robert. ***Performance Assessment Workshops in Mathematics and Science*****, 1994. Available from: University of Central Florida, College of Education, Orlando, FL 32816, (407) 823-5788.**

These training materials were developed for K-8 teachers to help them use performance assessments in math and science. Science process skills are assessed using a holistic, five-point, generic rubric that covers problem solving, reasoning, process skills, communication, connections, and content knowledge. Sample tasks include conducting an experiment with paper towels, organizing data from a table, and writing explanations of math applications. The notebook (100 pages) will be available in the fall of 1994 from the author.

(TC# 600.3PERASW2)

Fort Hays Educational Development Center, The. ***Science Rubrics Training*****, 1994. Available from: Steve Nolte, The Fort Hays Educational Development Center, 305 Picken Hall, Hays, KS 67601, (913) 628-4382, fax (913) 628-4084.**

The 1995 Kansas science assessment for grades 5, 8, and 11 has three parts: multiple choice, multiple mark, and performance based. The performance-based assessment consists of classroom-embedded problem-solving tasks. Overall specifications for the tasks are provided by the state, but teachers are responsible for designing specific activities. Student performance is scored using four traits: recognizing and defining the problem, designing the problem-solving strategy, implementing the problem-solving strategy, and implementing/communicating findings and conclusions.

This document is a set of materials developed by The Fort Hays Educational Development Center to train educators in its region on the Kansas state assessment. The document includes handouts from the training—rationale for the assessment, how to design meaningful group work, the science assessment rubrics, sample multi-step test questions, a sample performance-based project and student work samples, instructions for designing the group project, and Kansas science curriculum standards.

(TC# 600.3SCIRUT)

Gayford, Christopher. Group problem solving in biology and the environment, 1989-93. Available from: Department of Science and Technology, University of Reading, Reading, Berkshire RG6 1HY, England, UK, (073) 431-8867.

This document consists of three journal articles: *A Contribution to a Methodology for Teaching and Assessment of Group Problem Solving in Biology Among 15-Year Old Pupils* Located in <u>Journal of Biological Education</u> 23, 1989, pp. 193-198. *Patterns of Group Behavior in Open-Ended Problem Solving in Science Classes of 15-Year-Old Students in England.* Located in: <u>International Journal of Science Education</u> 14, 1992, pp. 41-49. *Discussion-Based Group Work Related to Environmental Issues in Science Classes with 15-Year-Old Pupils in England.* Located in: <u>International Journal of Science Education</u> 15, 1993, pp. 521-529.

The author reports on a series of related studies in which secondary students engaging in group work are assessed on a variety of skills such as group process, problem solving, attitudes, and science process. The purposes of the studies were to: (1) explore the use of group discussion as a way to develop and exercise skills such as communication, problem solving, and numeracy; (2) discover how students approach problem solving tasks; and (3) describe the group dynamics of students engaging in group problem solving tasks. The papers are included here because of the assessment devices developed by the author to examine student problem solving and process skills.

The specific tasks in which students were engaged in these studies were discussions of controversial issues about the environment and practical investigations in which students were to determine the best source of a substance or the amount of water needed by various plants. Students worked in groups. Each task took from 60-90 minutes. Performance was assessed using a variety of scoring guides, the most detailed of which was a generalized rubric assessing ability to state the problem, ability to work cooperatively as a team, quality of reasons for choice of design, ability to modify the design as a result of experience, and ability to evaluate success. Performance was rated on a three-point scale.

The papers include a good enough description of the tasks and scoring procedures that they could be reproduced by the reader. The paper also includes information about student performance on the tasks. No other technical information nor sample student responses are included. Permission to reproduce materials has been granted by the author.

(TC# 600.3CONTOM)

Germann, Paul J. ***Development of the Attitude Toward Science in School Assessment and Its Use to Investigate the Relationship Between Science Achievement and Attitude Toward Science in School.*** **Located in: <u>Journal of Research in Science Teaching</u> 25, 1988, pp. 689-703.**

The *Attitude Toward Science in School Assessment* (ATSSA) survey was based on a theoretical model which not only attempts to distinguish between different aspects of "attitude" but also additional factors that affect behavior. The ATSSA has 14 statements such as, "Science is fun"; students indicate their degree of agreement with the statement. The paper presents the results of several studies using the instrument with students in grades 7-10. As a result of the studies, the author concludes that, "The ATSSA is a valid and reliable instrument that can be useful in sorting out the relationships between variables that affect achievement and attituae School departments, science departments, and classroom teachers can use this assessment to monitor general attitude toward science in school among the students in their instructional programs." The entire instrument is included in the article.

(TC# 210.3DEVATT)

Gong, Brian, Richard Venezky, and David Mioduser. ***Instructional Assessments: Lever for Systemic Change in Science Education Classrooms.*** **Located in: <u>Journal of Science Education and Technology</u> 1, 1992, pp. 157-176.**

This article describes how the Educational Testing Service/University of Delaware Science Education project has addressed systemic change in science education through the use of assessment. The first part of the paper argues that instructional assessment is classroom-based, educational, self-administered, and empowers learners and teachers.

The second part of the article focuses on the design of instructional assessments. The project has worked with teachers and schools in grades 4-8 to develop, implement, and research the effects of instructional assessment materials and practices on science education. It has ueveloped sample instructional units dealing with science themes, explanatory principles, and causal models within the context of water resources, tools and technology, meteorology, and control systems. Each unit is problem-centered, and the units cross science disciplines and non-science areas such as art, mathematics, language arts, and social studies. Two descriptions of sample units—tools and technology and water resources—are presented. Unfortunately, the article does not include actual assessment materials or scoring rubrics.

Other types of lesson analysis and student diagnosis procedures are discussed. The final section of the article deals with staff development as a key to systemic change. The authors claim that instructional assessment has changed staff assessment focus from grading to content-based analyses.

(TC# 600.6INSASL)

Green, Barbara. ***Developing Performance-Based Assessments and Scoring Rubrics for Science*****, 1993. Available from: Texas Education Agency, Instructional Outcomes Assessment, 1701 N. Congress Ave., Austin, TX 78701, (512) 463-9734.**

This document consists of two grade 4 and 8 science process skills assessment tasks—design an insulating container for ice cubes (grade 4) and determine the absorbency of paper towels (grade 8). These illustrate the two basic kinds of tasks being developed in Texas—design and inquiry. Students plan and carry out their designs or inquiries at stations having a standard set of disposable and nondisposable materials. Students respond in writing (showing pictures, diagrams, and data displays when appropriate) to printed directions. For example, the grade 4 task asks students to plan the design (draw a picture and write a description), construct the design and test it, improve the design, and write a report (written analysis and conclusion).

Scoring uses a different holistic four-point scale for each of the two types of tasks—designs and investigations. For example, a "4" on design tasks means:

> The overall response is consistent with a sound scientific approach to design. The response indicates that the student has a clear understanding of the problem. The response may, in some cases, define additional aspects of the problem or include extensions beyond the requires of the task. Some inconsistencies may be present, but they are overwhelmed by the superior quality of the response. A score point '4' response is characterized by most of the following...

The package of materials we received has descriptions of the two tasks, a sample student response for each (unscored), and the scoring guide for each. No technical information is included. The contact person has given permission for educators to reproduce, for their own students, the materials submitted.

(TC# 600.3PERBAA)

Greig, Jeffrey, Naomi Wise, and Michal Lomask. *The Development of an Assessment of Scientific Experimentation Proficiency for Connecticut's Statewide Testing Program*, 1994. Available from: Connecticut State Department of Education, 165 Capitol Ave., Hartford, CT 06106, (203) 566-5677.

In the Connecticut Academic Performance Test (CAPT) design, students are given a hands-on laboratory activity during a four-week period prior to the administration of the written portion of the test. The task presents students with a real-world problem. Students work in pairs to define a specific research question, design and carry out experiments to solve the problem, and draw conclusions based on their results. An example of a CAPT science performance task is included. Students then work individually to write about their experiments and results in the form of a written lab report. These lab reports are not collected and scored at the state level. Rather, teachers are encouraged to score their own students' work and provide them with feedback.

During the written portion of the test, students are given follow-up questions which relate directly to the performance task. These questions are designed to assess students' ability to apply their understanding of scientific experimentation by critiquing sample results. The questions provide students with hypothetical experimental designs, results, and conclusions from the performance task and ask them open-ended questions about the quality of the work shown. Examples of the follow-up questions are included. The results of the follow-up questions are scored at the state level and used in combination with other items to formulate the students' experimentation score.

This paper also describes research that was conducted during the development of the CAPT science assessment to answer such questions as:

- Does completing the performance task affect students' scores on the follow-up questions?
- Does the amount of time between completing the performance task and the written test affect students' scores on the follow-up questions?
- What is the relationship between students' scores on their lab reports and on the follow-up questions?
- What is the relationship between students' prior experience in performing labs in their science classes and their scores on the follow-up questions?
- To what degree are the performance tasks comparable?

(TC# 600.3DEVASS)

Hall, Greg. *Performance Assessment in Science—STS Connections*, 1993. Available from: Alberta Education, Box 43, 11160-Jasper Ave., Edmonton, AB T5K 0L2, Canada, (403) 427-0010, fax (403) 422-4200.

The "Grade 9 Science Performance-Based Assessment" consists of six stations set up in a circuit at which students perform a variety of investigations. The six in the 1993 assessment include: seed dispersal, calibrating a hydrometer and using it to measure the density of a sugar solution, determining which of several choices is the best insulator, building a robot arm, testing for contaminates, and examining an environmental issue. Three circuits, accommodating a total of 15 students, is recommended. Each group requires two hours. Students respond in writing to a series of questions.

Responses for the Grade 9 assessment were scored on two dimensions: problem solving/inquiry skills and communication. The scoring guide is generalized (the same one is used across all tasks) and uses a four-point (0-3) scale. A "3" for Inquiry is: "Analyzed and readily understood the task, developed an efficient and workable strategy, strategy implemented effectively, strategy supports a qualified solution, and appropriate application of critical knowledge." A "3" for Communication is: "Appropriate, organized, and effective system for display of information or data; display of information or data is precise, accurate, and complete; and interpretations and explanations logical and communicated effectively."

The documents we have contain: a general overview of the procedures, complete activity descriptions, an administration script and the scoring guide. Student booklets for the 9th grade assessment, technical information and sample student responses are not included.

(TC# 600.3PERAST)

Hall, Greg. ***Science Performance Assessment and Standards: Just Do It!*, 1994. Available from: Greg Hall, 16 Ainsley Pl., St. Albert, Alberta, Canada T8N 5V8.**

This document is the 1994 version of Alberta Education's grade 6 and 9 science performance assessment intended to assess science inquiry, technological problem solving, and decision-making skills. Students complete six hands-on tasks set up in a circuit. The document includes a description of how to set-up the circuit; the materials needed for each station; and a two-trait, general scoring guide. No sample student responses or technical information are included. (Note: The grade 9 assessment is the same as that in 1993—see 600.3PERAST; but the material from grade 6 is different.)

(TC# 600.3JUSDOI)

Halpern, Diane (Ed.). ***Enhancing Thinking Skills in the Sciences and Mathematics*, 1992. Available from: Lawrence Erlbaum Associates, Publishers, 365 Broadway, Hillsdale, NJ 07642, (800) 926-6579.**

This book is not strictly about assessment. Rather, it discusses the related topics of "What should we teach students to do?" and "How do we do it?" The seven authors "criticize the conventional approach to teaching science and math, which emphasizes the transmission of factual information and rote procedures applied to inappropriate problems, allows little opportunity for students to engage in scientific or mathematical thinking, and produces inert knowledge and thinking skills limited to a narrow range of academic problems." (p. 118). In general, they recommend that teachers focus on the knowledge structures that students should know, use real tasks, and set up instruction that requires active intellectual engagement. The authors give various suggestions on how to bring this about: instructional methods, videodiscs, group work, and a host more. The final chapter analyzes the various positions and raises theoretical issues.

(TC#500.6ENHTHS)

Hardy, Roy. ***Options for Scoring Performance Assessment Tasks*, 1992. Available from: Educational Testing Service, 1979 Lakeside Parkway, Suite 400, Tucker, GA 30084**

Four assessment tasks were developed to explore the feasibility of performance assessment as part of a statewide assessment program. Tasks were: shades of color (grades 1-2), discovering shadows (grades 3-4), identifying minerals (grades 5-6), and designing a carton (grades 7-8). The tasks are described in the paper, but all of the relevant materials are not included. Each task was designed to take one hour. Most tasks are completed individually, but one (cartons) is a group task.

Response modes varied (multiple-choice, figural, short narratives, products), in part to see which are feasible, and in part to see how different kinds of scores relate to each other. Most scoring was right/wrong or holistic on degree of "correctness" of answer. Cartons was scored holistically on problem solving. The scoring procedures are not presented in detail. The paper also describes the process used to develop scoring rubrics, train scorers, and analyze the data. No sample student responses are included in this document.

The tasks were completed by 1,128 students from 66 classes in 10 school districts. Teachers completed a survey (questions are included in the paper). Results showed that it took from 1/2 to three minutes to score the performances, interrater agreement ranged from .76 to the high .90's, relationships between scoring procedures varied, and teachers liked the procedures. In all, the author concluded that it is feasible to use performance tasks in statewide assessment.

(TC#600.3OPTSCP)

Harlen, Wynne. ***Performance Testing and Science Education in England and Wales*****, 1991. Located in: Gerald Kulm and Shirley M. Malcom (Eds.), Science Assessment in the Service of Reform. Available from: American Association for the Advancement of Science, 1333 H St. NW, Washington, DC 20005 [AAAS Books: (301) 645-5643].**

This is a good summary of the approach to science education and assessment in England and Wales. (For related information, see the entries under Chris Whetton.) It discusses the history of the project, provides three hands-on test questions as examples, and describes the issues and problems which have arisen thus far— comparability of tasks, amount of reading required by students, and trying to accomplish too many purposes with a single assessment.

From the examples provided, it appears that the performance tasks are a series of open-response questions which address a single science process skill, e.g., interpreting information, planning an investigation, or observing. Students provide short-answers which are evaluated according to degrees of completeness or right/wrong. Criteria differ by task.

(TC#600.6PERTES)

Hein, George E. and Sabra Price. ***Active Assessment for Active Science—A Guide for Elementary School Teachers*****, 1994. Available from: Heinemann, 361 Hanover St., Portsmouth, NH 03801.**

This short book provides a somewhat cursory overview of:

- rationale for changes in assessment
- types of assessment
- managing assessment
- performance assessment
- grading

The book does a reasonable job discussing performance criteria for assessing general science process skills and managing assessments in the classroom. The target audience is teachers of students in grades 1-6.

(TC# 600.6ACTASA)

Helgeson, Stanley. ***Assessment of Science Teaching and Learning Outcomes,*** **1993. Available from: The National Center for Science Teaching and Learning, 104 Research Center, 1314 Kinnear Rd., Columbus, OH 43212, (614) 292-3339.**

The author provides a nice summary of the following topics: purposes of student assessment in science, results of national and international assessments, the effects of high stakes assessment on instruction, assessment of attitudes in science, computer applications, and reasons for alternative assessment.

(TC#600.6ASSSCT)

Helgeson, Stanley L., and David D. Kumar. ***A Review of Educational Technology in Science Assessment,*** **1993. Available from: The National Center for Science Teaching and Learning, 1929 Kenny Rd., Columbus, OH 43210, (614) 292-3339.**

The authors found that most current use of technology consists mainly of computerized administration of multiple-choice tests drawn from item banks. However, they also describe some more innovative applications such as computer generated test questions, laboratory simulations, and computer scoring of more open-ended tasks. However, most of these appear to be based on assessing content and procedural knowledge rather than thinking skills.

(TC# 600.6REVEDT)

Hibbard, K. Michael. ***What's Happening?,*** **1991. Available from: Region 15 School District, PO Box 395, Middlebury, CT 06762, (203) 758-8250.**

This document is a series of performance tasks in which assessment is integrated with instruction. The tasks include: chemical reaction, consumer action research, plant growth, physiological responses of the human body, survival in the winter, science fiction movie development, and food webs. Each task includes assessment rating forms and checklists, some of which are designed for student self-assessment. For example, the *survival in winter* exercise includes a rating scale that assesses 12 features of the project on a scale of 1-5, and a rating scale for an oral presentation. Other tasks include performance criteria for group work and self-rating on perseverance. The performance criteria are a mixed bag. Some directly refer to specific features of the task (e.g., "detailed descriptions were given of each plants' growth"). Others are general features that could be applied to many tasks (e.g., "shows persistence"). However, there is no standard of criteria across tasks; there is a different number of criteria and a different mix of specific and general criteria depending on task.

The assessments were developed for classroom use and do not include detailed definitions of traits to be rated, nor sample anchor performances. No technical information is included.

(TC#600.3WHAHAP)

Horn, Kermit, and Marilyn Olson. ***1992-1993 Lane County Fourth Annual Project Fair—Official Guidelines, Criteria & Registration Forms for Grades K-12.*** **Available from: Kermit Horn or Marilyn Olson, Project Fair Coordinators, Instructional Services Division, Lane Education Service District, PO Box 2680, Eugene, OR 97402, (503) 689-6500.**

This handbook is given to students (grades K-12) interested in registering for the Lane County project fair. It contains information on registration, criteria by which projects will be judged, and help with getting started. The document also gives some excellent ideas on interdisciplinary projects. No samples that illustrate score points on criteria are included; the criteria, although an excellent start, are still a little sketchy.

(TC# 000.3LANCOP)

Illinois Science Teachers Association. ***Science Performance Assessment Handbook—Draft,*** **1993. Available from: Illinois State Board of Education, 100 N. First St., Springfield, IL 62777, (217) 782-4321, fax (217) 782-0679.**

This handbook "is designed to provide assistance to the instructor who is attempting to develop performance assessments along with the procedures for administering them." It contains a very brief textual section that covers definitions and basic assessment concepts. This description might be too brief or complex for some readers. The bulk of the document is made up of sample assessments which include complete administration instructions but no technical information. All scoring is task specific, except where noted.

- *Hands On Tests for Science* (primary grades). Students complete simple hands-on activities at five stations—classification of objects, measurement, making observations, drawing inferences, and making predictions (10 minutes per station).

- *A Science Investigation* (grades 3-5). Students collect information, make a graph, make predictions from their data, and write-up what they did (1 hour).

- *Relative Humidity* (group project, grade 7). Groups choose one of six investigations and are given two weeks to plan, carry out, and write up the results. Students are scored on lab work, written report, cooperation, and oral presentation. The scoring guide is general but sketchy.

- Design an experiment to test a hypothesis (middle school). Scoring focuses on quality of explanation, but guidelines are sketchy.

- Mirror image construction (middle school).

- Densities of liquids and solids (high school). Responses are scored using a general rubric along three dimensions: experimental design, observations and calculations, and conclusions.

- Battery and bulbs (portfolio, middle school). Some content is specified by the technical information; students get to choose some content. No criteria are provided.

(TC# 600.3SCIPAH)

Johnson, David W., and Roger T. Johnson. ***Group Assessment as an Aid to Science Instruction*****, 1990. Located in: Champagne, Lovitts and Calinger (Eds.), <u>Assessment in the Service of Instruction</u>, 1990, pp. 267-282. Available from: American Association for the Advancement of Science, 1333 H St. NW, Washington, DC 20005 [AAAS Books: (301) 645-5643]. Also located in: G. Kulm & S. Malcom (Eds.), <u>Science Assessment in the Service of Reform</u>, 1991, pp. 103-126, AAAS.**

The authors favor cooperative learning in science because of research that shows positive effects on student learning and attitudes. Group assessment involves having students complete a lesson, project, or test in small groups while a teacher measures their level of performance on reasoning processes, problem solving, metacognitive thinking, and group interactions. The authors also maintain that this procedure increases the learning it is designed to measure, promotes positive attitudes toward science, parallels instruction, and reinforces the value of cooperation. The article describes how to structure performance tasks in a cooperative framework. The authors then describe, in general, different ways to record the information from the task—observational records, interviews, individual and group tests, etc. This is only a general overview of the possibilities and provides no specific rubrics, forms, or questions.

(TC#600.6GROASA)

Jones, Lee R., Ina V.S. Mullis, Senta A. Raizen, et al. ***The 1990 Science Report Card—NAEP's Assessment of Fourth, Eighth, and Twelfth Graders.*** **Available from: Education Information Branch, Office of Educational Research and Improvement, US Dept. of Education, 555 New Jersey Ave NW, Washington, DC 20208, (800) 424-1616.**

The National Assessment of Educational Progress (NAEP) is congressionally mandated. This document includes the results of the 1990 Science Assessment from NAEP. It includes sample exercises, some of which are multiple-choice and others are open-ended.

(TC# 600.6SCIREC2)

Jones, M. Gail. ***Performance-based Assessment in Middle School Science.*** **Located in: Middle School Journal 25, March 1994, pp. 35-38.**

The author presents some ideas on how to do performance-based classroom assessments of science process skills. She recommends reviewing units of study to analyze the process skills being emphasized, identifying the observable aspects of each skill, and designing tasks that allow you to observe the skills. The author illustrates this process in various ways—both by giving an extended example on coastal ecology, and by listing science process skills, some observable behaviors, and related examples of tasks students could be given to elicit the behavior. The discussion of how to score responses is not as complete. No technical information is provided.

(TC#600.6PERBAS)

Jungwirth, Ehud, and Amos Dreyfus. ***Analysis of Scientific Passages Test,*** **1988. Available from: Educational Testing Service, Tests in Microfiche, TC922019, Set R. Also referenced in: "Science Teachers' Spontaneous, Latent or Non-attendance to the Validity of Conclusions in Reported Situations," Research in Science and Technological Education 8, 1990, pp. 103-115.**

The authors have developed a measure of science teacher critical thinking. Teachers are asked to identify the similarities between two passages in which the same invalid conclusion is reached. Passages illustrate "post hoc" thinking; attributing causality to an antecedent event; drawing conclusions about a population from a non-representative sample; and acceptance of tautologies as explanations. Teachers respond in writing. There are four forms. No technical information, except performance of one group of 76 teachers, is available.

(TC#600.4ANASCP)

Kamen, Michael. ***Use of Creative Drama to Evaluate Elementary School Students' Understanding of Science Concepts,*** **1991. Located in: G. Kulm and S. Malcom (Eds.), Science Assessment in the Service of Reform, 1991, pp. 338-341. Available from: American Association for the Advancement of Science, 1333 H St. NW, Washington, DC 20005 [AAAS Books: (301) 645-5643].**

This article emphasizes kinesthetic learning—reinforcing and assessing knowledge of scientific concepts through acting them out. For example, students can demonstrate their knowledge of waves by forming a line and creating waves with different wave length and amplitude. Other examples are given for air pressure, solar energy, and land snails. The assessment appears to occur by seeing the extent to which students can illustrate the concept properly. No other performance criteria are discussed. Tasks were designed for students in grades K-6.

(TC#600.6USECRD)

Kanis, I. B. *Ninth Grade Lab Skills.* **Located in: The Science Teacher, January 1991, pp. 29-33.**

This paper provides a summary description of the six performance tasks given to ninth grade students as part of the 1985-86 Second International Science Study to assess laboratory skills. A brief description, a picture of the lab layout, and a list of scoring dimensions are provided for each task. It appears that scoring is essentially right/wrong and task-specific. Students were scored on ability to manipulate material, collect information, and interpret results. A brief discussion of some results of the assessment are provided. There is enough information here to try out the tasks, but not enough to use the performance criteria. No sample student performances are included. The paper also discusses problems with many current lab activities (too cookbook) and how to redesign lab exercises to promote higher-order thinking skills.

(TC#600.3NINGRL)

Kentucky Department of Education. ***Kentucky Instructional Results Information System (KIRIS)*, 1993-94. Available from: Kentucky Department of Education, Division of Accountability, 1900 Capital Plaza Tower, 500 Mero St., Frankfort, KY 40601, (502) 564-4394.**

The *Kentucky Instructional Results Information System* is an assessment program that monitors grades 4, 8, and 12 student achievement in reading, social studies, science, and mathematics. The assessment has three parts: multiple choice/short essay, performance assessment, and portfolios. Assessment results place students in one of four performance levels: novice, apprentice, proficient, or distinguished. The document we received contains grade 4, 8, and 12 performance assessment items in reading, social studies, science, and mathematics. All items are paper and pencil. Task-specific scoring guides are included.

(TC# 060.3KIRIS94)

Kentucky Department of Education. ***Performance Events, 1992-93, Grade 8.*** **Available from: Kentucky Department of Education, Capital Plaza Tower, 500 Mero St., Frankfort, KY 40601, (502) 564-4394.**

This document includes three performance tasks and related scoring guides from the 1993 grade 8 assessment. The tasks relate to mapping the ocean floor, identifying bones, and water pollution. There is both group and individual work using a variety of manipulatives. Each task consists of a a series of related questions, some of which have only one right answer and some of which are more open-ended. Scoring employs task-specific scoring guides developed from a generic guide that covers completion of the task, understanding, efficiency/ sophistication, and insight. Scored student responses are included. No technical information is included.

(TC#600.3PEREVG)

Khattri, Nidhi. *Performance Assessments: Observed Impacts on Teaching and Learning*, **1995. Available from: Pelavin Associates, 2030 M St. NW, No. 800, Washington, DC 20036.**

The author attempted to document the impact of performance assessment on teaching and learning. The author visited 14 schools in fall 1994 and spring 1995 to examine student work; observe in classrooms; and interview school personnel, students, and parents.

The authors report the following findings: "(1) students are being asked to write, to do project-based assignments, and to engage in group learning due to the use of performance assessments; and (2) as a result of project-based assignments, students are more motivated to learn. Furthermore, because of the use of performance-based assignments and the degree of freedom accorded to students in shaping their own work...collaboration is evident. Increasingly, teachers are viewing students as active learners."

All of the effects depended on: (a) the form of the assessment (e.g., portfolio or performance event); (b) the degree of integration of the assessment into the classroom; and (c) the level of support provided to incorporate the assessment into routine classroom activities. The positive effects on teaching are most evident for sites using portfolio assessments, mostly because the portfolio format provides teachers and students control over products coupled with a structure for documenting student work and student progress on an ongoing basis.

(TC# 150.6PERASO)

Kleinsasser, Audrey, Elizabeth Horsch, and Denise Wheeler. *Teacher-Researchers Investigating Science and Math Performance Assessments: Expanding Traditional Roles*, **1995. Available from: Audrey Kleinsasser, Box 3374, College of Education, University of Wyoming, Laramie, WY 82071.**

The authors describe four teacher-researcher projects on the impact of the use of classroom-based performance assessments. The authors conclude that there is value in student-directed learning and assessment, and teacher-student assessment collaboration.

(TC# 600.6TEAREI)

Koballa, T.R. *Goals of Science Education*, **1989. Located in: D. Holdzkom and P. Lutz (Eds.), Research Within Reach: Science Education, pp. 25-40. Available from: National Science Teachers Association, Special Publications Department, 1742 Connecticut Ave. NW, Washington, DC 20009, (202) 328-5800.**

Assessment should be designed to cover important student processes and outcomes. This article is included because it discusses what our goals for students should be. Specifically, the author maintains that most science curricula are oriented toward those students that want to pursue science academically and professionally. We should also, however, be looking at science education as a means of promoting other important goals for students such as: wanting to know and understand, respect for logic, and capacity to cope with change.

(TC#600.5GOASCE)

Kober, Nancy. ***What We Know About Science Teaching and Learning*****, 1993. Available from: Council for Educational Development and Research (CEDaR), 2000 L Street, NW, Suite 601, Washington DC 20036, (202) 223-1593.**

This booklet provides a very nice summary and overview of the changes in science instruction and assessment and the reasons for the changes. It includes short sections on such topics as: why science is important for all citizens, why science instruction needs to change, instructional ideas, implications for policy, curriculum standards, how to send the message that science is important, equity issues, instructional methods, staff development needs of teachers, and the role of parents and the community.

(TC#600.6WHAKNS)

Kulm, Gerald, Shirley M. Malcom. ***Science Assessment in the Service of Reform*****, 1991. Available from: American Association for the Advancement of Science, 1333 H St. NW, Washington, DC 20005 [AAAS Books: (301) 645-5643].**

This book contains articles from various authors who discuss: current issues surrounding science assessment, the rationale for considering alternatives, curriculum issues and trends, and alternative assessment initiatives in various states and countries. (The latter is somewhat out-of-date.) The individual articles that appeared to be of most interest to users of this bibliography are entered separately.

(TC#600.6SCIASI)

Lawrence, Barbara. ***Utah Core Curriculum Performance Assessment Program: Science*****, 1993. Available from: Profiles Corporation, 507 Highland Ave., Iowa City, IA 52240.**

The Utah State Office of Education has developed 90 constructed response items in mathematics, science and social studies (five in each of grades 1-6 for each subject) to complement multiple-choice tests already in place. Assessments are designed to match the Utah Core Curriculum. Although districts must assess student status with respect to core-curriculum goals, use of the state-developed assessments is optional.

The science assessments are designed to measure four general process skills: identify/describe, explain, infer, organize, and create. Each task has several questions relating to a common theme. For example, one grade 3 task takes students through a simulated walk in the woods. A series of activities asks students to do such things as: "Color an animal and its surroundings in a way that shows how the animal uses camouflage...;" and "Next to each animal paste the picture of an animal or animals likely to use that shelter." Most student responses are short (some are multiple-choice); the longest are no more than a paragraph.

Scoring is task-specific and based either on getting the correct answer (e.g., the score for pasting animals next to shelters is 0-3 depending on how many are done correctly) or quality of the response (e.g., the score for camouflage is 0-2, where 2 is "student colors one of the animals in a way that enhances its camouflage" and 1 is "student partially addresses the task.") Points are totaled for each task, and between tasks for each of the four process skills assessed. Four levels of proficiency on each skill are identified: advanced, proficient, basic and below basic. Cut scores for each level are based on percent correct and behavioral descriptions of performance at each level.

Assessment activities are bound in books for each grade level/subject. Each task includes teacher directions, student test-taking materials, and scoring guides. The Office of Education has collected information on teacher reaction to the assessments. No other technical information is available. An introductory training video is available which helps teachers use the assessment program (but does not deal specifically with science.)

(TC# 600.3UTACOC and 000.6INTUTCv—*video*)

Lawrence Hall of Science. *Full Option Science System—Water Module*, 1992. Available from: Encyclopedia Britannica Educational Corporation, 310 S. Michigan Ave., Chicago, IL 60604, (800) 554-9862. Also available from: Lawrence Hall of Science, University of California, Berkeley, CA 94720, (510) 642-8941.

The *Full Option Science System* is a series of hands-on instructional modules with associated assessments. The module reported here is on water. There are three parts to the assessment, all of which are described in detail in the document. The first part is a series of hands-on activities set up in stations. Examples are: "Put three drops of mystery liquid on wax paper and observe what happens." and "What do your observations tell you about the mystery liquids?" Two different testing configurations are outlined (8 students and 24 students). Each group takes about 30 minutes. The second part of the assessment is an open-response paper and pencil test that takes about 15 minutes. The third part of the assessment is an application of concepts in paper and pencil format that takes about 20 minutes. All answers are scored for degree of correctness. Administration and scoring information is provided, but no technical information on the tests nor information about typical performance is given.

(TC#600.3FOSSWM)

Lee, Elaine P. *Discovering the Problem of Solid Waste: Performance Assessments*, 1991. Available from: Lake County Educational Service Center, 19525 W. Washington St., Grayslake, IL 60030, (708) 223-3400.

In this booklet, 17 performance tasks on solid waste are presented for students in grades 3-6. Each performance task contains information about grade level, concepts being assessed (e.g., types of solid waste or recognizing changes in materials in a landfill), process skills needed to complete the task (e.g., classifying, measuring, observing, or ordering), and the objects/items needed for the task, directions, and questions to answer. Many of the tasks are completed at home or at a work station in the classroom. Scoring emphasizes the correctness of the response; the scoring guides are different for each task. The guide provides information on the maximum points to assign for each question and for the entire task. No information on staff training or technical information is provided.

(TC#620.3DISPRS)

Liftig, Inez Fugate, Bob Liftig, and Karen Eaker. ***Making Assessment Work: What Teachers Should Know Before They Try It.*** **Located In: Science Scope 15, March 1992, pp. 4-8.**

The authors contend that students have trouble taking alternative assessments because they have no practice doing do. For example, they don't know the higher-order thinking skills vocabulary that is often used in performance tasks, so they don't know what to do. They also don't know what it takes to do well. The authors recommend that students learn vocabulary, practice oral and written communication, and are careful not to leave anything out because they figure that the teacher already knows the student knows it. A list of vocabulary is included.

(TC#600.6MAKASW)

Lock, Roger. ***Gender and Practical Skill Performance in Science.*** **Located in: Journal of Research in Science Teaching 29, 1992, pp. 227-241.**

This paper is included because of its brief descriptions of the performance tasks used to assess practical skill. The four tasks were: measuring the rate of movement of blow fly larvae in dry and damp atmospheres, finding out how the size of the container with which a burning candle is covered affects the length of time for which the candle burns, determining the mass supported by a drinking straw, and identifying an unknown solution. Only one of these (straws) is described in enough detail to replicate. There are separate performance criteria for each task. Student performance is assessed live by listening to what the student says while he or she does the task, by watching what the student does, and by looking at what the student writes down. The criteria for the unknown solution task are given.

Because of the nature of the research reported, some technical information is included on the tasks. An attempt to obtain more information from the author was unsuccessful.

(TC#600.6GENPRS)

Lunetta, Vincent N., and Pinchas Tamir. ***Matching Lab Activities*****. Located in: The Science Teacher 46, May 1979, pp. 23-25.**

The authors list 24 skills and behaviors related to the scientific process, recommend using these skills to analyze the tasks given to students to make sure that students are being required to apply/use all the skills of importance, and report on a study in which they analyzed several tasks using the list. They discovered that most lab activities do not require students to use many of the skills on the list

(TC#600.6MATLAA)

Macdonald Educational. ***Learning Through Science*****, 1989. Available from: Macdonald Educational, Wolsey House, Wolsey Road, Hemel Hempstead HP2 4SS, England, UK. Also available from: Teachers' Laboratory, Inc., PO Box 6480, Brattleboro, VT 05301, (802) 254-3457.**

This is one of a series of publications developed to promote instructional reform in science in the United Kingdom. The reform movement emphasizes active learning and concept development. In addition to sections covering such topics as "why do science" and how to organize instruction, one chapter covers record keeping. This chapter proposes keeping track of student development toward mastery of broad scientific concepts and habits of thought rather than keeping track of activities completed. The chapter provides a brief description of a rating procedure (presented in more detail in another publication) for 24 attributes such as: curiosity, perseverance, observing, problem solving, exploring, classifying, area, and time. A sample five-point rating scale for one of the attributes, curiosity, is given.

An appendix to the book also provides developmental continua for: attitudes, exploring observations, logical thinking, devising experiments, acquiring knowledge, communicating, appreciating relationships, and critical interpretation of findings. These could be adapted for use in keeping track of student progress in a developmental fashion.

(TC#600.6LEATHS)

Macdonald Educational. ***With Objectives in Mind*****, 1984. Available from: Macdonald Educational, Wolsey House, Wolsey Road, Hemel Hempstead HP2 4SS, England, UK. Also available from: Teachers' Laboratory, Inc., PO Box 6480, Brattleboro, VT 05301, (802) 254-3457.**

This is one of a series of publications developed to promote instructional reform in science in the United Kingdom. This instructional reform emphasizes active learning and concept development. This document covers such topics as the contribution of science to early education, objectives for children learning science, and how to use the various instructional units that have also been produced as part of this series. There is a good discussion of how student understanding in science develops, which includes many samples of student behavior as illustrations of the various stages. This discussion could be adapted to constructing developmental continua for tracking student progress to be used for performance assessment.

(TC#600.6WITOBM)

Marshall, G. *Evaluation of Student Progress*, 1989. Located in: D. Holdzkom and P. Lutz (Eds.), Research Within Reach: Science Education, pp. 59-78. Available from: National Science Teachers Association, Special Publications Department, 1742 Connecticut Ave. NW, Washington, DC 20009, (202) 328-5800.

This paper presents a general overview of assessment development targeted at classroom teachers. The author emphasizes the need to clearly define outcomes for students and then match the outcome to the proper assessment technique—multiple-choice, essay, projects, practical tests and lab reports. Examples of each item type (using science content) are provided.

(TC#600.6EVASTP)

Martinello, Marian L. *Martinello Open-ended Science Test (MOST)*, 1993. Available from: University of Texas at San Antonio, Division of Education, San Antonio, TX 78249, (210) 691-5403, fax: (210) 691-5848.

This assessment is designed to be administered as a pretest and posttest of scientific observation, inference, and supporting evidence skills for children in grades 2-5. A child is given an unknown object to examine (e.g., a crinoid, sweet gum seedpod, oak gall) and is asked to respond to three specific questions: (1) What do you see? (2) What do you think it is? (3) Why do you think so? Responses can be oral or written. Responses are scored by assigning points for each reasonable observation made, inference made, or piece of supporting evidence given by the student. The document includes a description of the general procedure and scored examples of student responses to "oakgalls" and "seed pods." Technical information is available from the author. Also, samples of student written responses are available.

(TC# 600.3MAROPS)

Maryland Assessment Consortium. *Information Packet*, 1993-94. Available from: Jay McTighe, Maryland Assessment Consortium @Frederick County Public Schools, 115 E. Church St., Frederick, MD 21701, (301) 694-1337, fax (301) 694-1800.

This handout contains an overview of the Maryland Assessment Consortium and two sample elementary assessment tasks. The first is an integrated task (social studies, science, and writing) which requires students to compose an "Aesop's Fable" after reading and analyzing one and discussing where they come from. The second is a math activity on planning a backpacking trip. Some scoring is task specific and some is generalized. Task-specific scoring tends to be used for knowledge questions and generalized scoring tends to be used for "big" outcomes such as problem solving. No student work or technical information is included.

(TC# 000.3MARASC)

Maryland Assessment Consortium. ***Performance Assessment Tasks Elementary Level, Volume 6*** **and** ***Performance Assessment Tasks Middle School, Volume 7*****, 1994-95. Available from: Jay McTighe, Maryland Assessment Consortium @Frederick County Public Schools, 115 E. Church St., Frederick, MD 21701, (301) 694-1337, fax (301) 694-1800.**

The Maryland Assessment Consortium has published two notebooks of sample performance tasks in language arts, science, social studies, and mathematics. Some tasks are integrated across these areas. *Performance Assessment Tasks, Volume 6* contains 13 elementary tasks and *Volume 7* contains 9 middle school tasks. Each task includes complete instructions, test booklets and scoring guide, extension activities, special education modifications, and references. Many tasks have several activities related to a theme—group work, hands-on activities, reading and interpreting materials, and writing in subject matter areas. Performance criteria tend to be task-specific with separate criteria for each part of the task. All tasks have been pilot tested. No technical information nor sample student work are included. This document includes one sample elementary task and one sample middle school task. Full sets are available from the author.

(TC# 000.3PERAST)

Maryland State Department of Education. ***MSPAP (Maryland School Performance Assessment Program) Public Release Task—Soil Investigations, Grade 3, Science; Salinity, Grade 5, Science Language Usage;*** **and** ***Planetary Patterns, Grade 8, Science Language Usage.*** **Available from: Gail Lynn Goldberg, Maryland Department of Education, Maryland School Performance Assessment Program, 200 W. Baltimore St., Baltimore, MD 21201, (401) 333-2000.**

This document contains sample tasks for the 1994 Maryland hands-on science assessment for grades 3, 5, and 8. There is one task for each grade. Materials include the student response booklets, materials needed for the task, teacher administration instructions, and scoring guides (complete with sample student responses). Tasks involve both individual and group work, consist of several activities related to a theme (such as soil investigation or salinity), hands-on tasks, and written responses. Each part of each task is scored separately with a task-specific scoring guide. In grades 5 and 8 some student responses are also scored for language usage using a generalized scoring guide. No technical information is included.

(TC# 600.3MSPAPS)

Massell, Diane, and Michael Kirst, Eds. ***Setting National Content Standards.*** **Education and Urban Society 26, February 1994.**

This entire journal is a series of articles on the standards' setting process in several content areas with a summary of the issues and suggestions for approaches.

(TC# 000.5SETNAC)

McColskey, Wendy, and Rita O'Sullivan. ***How to Assess Student Performance in Science: Going Beyond Multiple-Choice Tests,*** **June 1993. Available from: SouthEastern Regional Vision for Education (SERVE), PO Box 5367 Greensboro, NC 27435, (800) 755-3277.**

This publication presents a nice, relatively short, summary of assessment possibilities and steps for developing assessments in science. There are sections that cover: deciding on student outcomes, matching outcomes to assessment type, developing performance criteria, and reflecting on grading practices.

(TC#600.6HOWASS)

McDonald, Joseph P., Sidney Smith, Dorothy Turner, et al. ***Graduation by Exhibition—Assessing Genuine Achievement,*** **1993. Available from: Association for Supervision and Curriculum Development, 1250 N. Pitt St., Alexandria, VA 22314, (703) 549-9110, fax (703) 549-3891.**

This book describes a strategy for school reform called "planning backwards from exhibitions." In this approach, schools define a vision of what they want for graduates by proposing a task they want graduates to do well. Having set the vision, they have students perform the task and compare the vision against actual performance. Then they plan backwards what students would need to know and be able to do at various grades or ages in order to be able to do well on the task.

This booklet describes this process with three case studies, each proposing a different task "platform" against which they guage student success—writing a position paper, inquiring and presenting, and participating in discussion seminars.

(TC# 150.6GRAEXA)

McTighe, Jay. *Developing Performance Assessment Tasks: A Resource Guide*, **October 1994. Available from: Maryland Assessment Consortium, c/o Frederick County Public Schools, 115 E. Church St., Frederick, MD 21701. (301) 694-1337.**

This is a notebook of performance assessment "must reads." The authors have assembled their favorite papers on: definitions, overview of performance assessment, and designing performance tasks and criteria. The notebook also contains Maryland's learner outcomes.

(TC# 150.6DEVPEA)

Medrich, Elliott A., and Jeanne E. Griffith. ***International Mathematics and Science Assessments: What Have We Learned?*****, 1992. Available from: National Technical Information Service, US Dept. of Commerce, 5282 Port Royal Rd., Springfield, VA 22161, (703) 487-4650.**

This report provides a description of international assessments of math and science from the 1960's to 1988 including findings and the issues surrounding the collection and analysis of the data. It also offers suggestions about ways in which new data collection standards could improve the quality of the surveys and the utility of future reports.

(TC# 000.6INTMAS)

Meng, Elizabeth and Rodney L. Doran. ***Improving Instruction and Learning Through Evaluation—Elementary School Science*****, May 1993. Av 'lable from: ERIC, Clearinghouse for Science, Mathematics and Environmental Education, The Ohio State University, 1929 Kenny Rd., Columbus, OH 43210, (800) 443-ERIC.**

This excellent short book describes current thinking on the goals of science education. It provides sample ways of assessing science process skills, concepts and problem solving, and ways to collect and use information.

(TC# 600.6IMPINL)

Mergendoller, J.R., V.A. Marchman, A.L. Mitman, and M.J. Packer. ***Task Demands and Accountability in Middle-Grade Science Classes*****, 1987. Located in: <u>Elementary School Journal</u> 88, pp. 251-265.**

The authors maintain that the types of thinking students engage in and the quality of learning that occurs are largely influenced by the nature of the tasks students complete. After analyzing a large number of instructional and assessment tasks given to eighth graders, the authors conclude that, in general, the tasks given students present minimal cognitive demands. The article also provides suggestions about analyzing and modifying curriculum tasks.

Although not strictly about assessment, the article is included here to reinforce the notion that, as in instruction, the task given to students in a performance assessment can affect how well one can draw conclusions about student ability to think—if students are not given performance tasks that require thinking, it would be difficult to analyze responses for thinking ability.

(TC#600.6TASDEA)

National Assessment of Educational Progress (NAEP—1987). ***Learning by Doing: A Manual for Teaching and Assessing Higher-Order Thinking in Science and Mathematics. Report No. 17-HOS-80*****, 1987. Available from: Educational Testing Service, CN 6710, Princeton, NJ 08541, (800) 223-0267.**

The National Assessment of Educational Progress was established in 1969 to monitor student achievement status and trends. Samples of students aged 9, 13 and 17 are tested periodically, with science assessments having occurred in 1970, 1973, 1982, 1986, and 1990.

Learning by Doing is an overview of a pilot test of "higher-order thinking skills" that was added to the 1986 assessment. This pilot consisted of 30 tasks/items in the areas of sorting/classifying, observing/formulating hypotheses, interpreting data, and designing/conducting an experiment. The tasks included open-ended paper and pencil items, use of equipment at stations, and complete experiments. *Learning by Doing* briefly describes 11 of the exercises presented to students. Scoring is not described in detail. (The full report is available from NAEP at the above address.)

Lisa Hudson in chapter 4 of *Assessment in the Service of Instruction* (TC#600.6ASSINT) discusses some issues with respect to this pilot test and the 1990 science assessment. These include whether the time and cost of giving the performance items really provides that much extra information; how the ability to read, listen, and write might affect scores; and whether this type of task would differentially encourage inquiry-based instruction. (These are questions that relate to all performance assessments and not just the NAEP pilot.)

(TC#050.6LEABYD)

National Center for Improving Science Education. ***Getting Started in Science: A Blueprint for Elementary School Science Education*****, 1989. Available from: National Center for Improving Science Education, 2000 L St. NW, Suite 602, Washington, DC 20036, (202) 467-0652. Also available from ERIC: ED 314 238.**

This report covers such topics as the rationale for science instruction, how children learn science, teacher development and support, and assessment. The chapter on assessment promotes the idea of assessment in the service of instruction—measuring the full range of knowledge and skills required for science, alignment with instruction, and a range of assessment approaches. The authors outline the characteristics of a good assessment system, including characteristics of tests, measuring affective as well as cognitive dimensions, and assessing instruction and curriculum.

(TC#600.6GETSTS)

National Research Council. ***National Science Education Standards—Draft,*** **November 1994. Available from: National Academy Press, PO Box 285, Washington, DC 20055, (800) 624-6242.**

The goal of the *National Science Education Standards* is to "Create a vision for the scientifically literate person and standards for science education that, when established, would allow the vision to become reality." This draft includes standards for teaching science, professional development of science teachers, assessment, programs and systems, and content (what should be taught).

The primary goals for school science are to create students who are able to:

- Use scientific principles and processes appropriately in making personal decisions
- Experience the richness and excitement of knowing about and understanding the natural world
- Increase their economic productivity, and
- Engage intelligently in public discourse and debate about matters of scientific and technological concern

The final version will be available late in 1995.

(TC# 600.5NATSCE2)

Office of Educational Research and Improvement (OERI). ***Improving Math and Science Assessment. Report on the Secretary's Third Conference on Mathematics and Science Education.*** **Available from: U.S. Government Printing Office, Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402.**

This 15-minute video and companion booklet covers highlights of the secretary's third "Conference on Mathematics and Science Education: Improving Math and Science Assessment" during which more than 550 educators, researchers, and policymakers addressed such questions as "Why must assessment change?" "What forms of math and science assessments can help American students succeed in these subjects?" "How can districts reforming assessment assure that tests are fair for students of all races and income levels and both genders?" "How can better assessments fuel the drive toward comprehensive reform of American education and higher academic standards?" Recommendations, insights and information from the conference are incorporated into the video and the accompanying report. This annual event is sponsored by the US Department of Education.

(TC# 000.6IMPMASv and 000.6IMPMASt)

O'Rafferty, Maureen Helen. ***A Descriptive Analysis of Grade 9 Pupils in the United States on Practical Science Tasks*****, 1991. Available from: University Microfilms International Dissertation Services, 300 N. Zeeb Rd., Ann Arbor, MI 48106, (800) 521-0600, microfilm #913 5126.**

This dissertation was a re-analysis of some of the information from the Second International Science Assessment (SISS), 1986, but it also includes a good description of the performance portion of the SISS and three of the six performance tasks. (The SISS also contained a multiple-choice portion and several surveys.)

The three tasks included in this document (Form B) were: determining the density of a sinker, chromatography observation and description, and identifying starch and sugar. The other three tasks (Form A) in the SISS, not included in the document, are: using a circuit tester, identifying solutions by ph, and identifying a solution containing starch. Each task has a series of questions for the student to answer using the equipment provided. The questions asked students to observe, calculate, plan and carry out a simple experiment, explain, and determine results. Each subquestion was classified as assessing one of three types of process skills: performing, reasoning, or investigating. The six tasks were set up at 12 alternating stations A, B, A, B, ...). Twelve students could be tested every 45 minutes. One to two points were given for each answer. The basis for assigning points was not clear, but appears to be based on a judgment of the correctness of the response.

The dissertation includes a number of student responses to the tasks, overall performance of the US population, and several reinterpretations of the results. For example, student performance on questions classified as measuring the same skill were widely different. The author speculates that this is either because the definitions of the skills are imprecise, or because such unitary skills don't exist. The author also examined student responses for patterns of errors, and discussed the implications of this for instruction.

(TC#600.3DESANP)

Oregon New Standards Project. ***Student Portfolio Handbook—Quantify/ Science/ Mathematics—Field Trial Version/Elementary*****, 1994. Available from: Oregon Deptment of Education, Public Service Bldg., 255 Capitol St NE, Salem, OR 97310, (503) 378-8004. Also available from: New Standards at the National Center on Education and the Economy, 39 State St., Suite 500, Rochester, NY 14614, (716) 546-7620, fax (716) 546-3145.**

This document describes the elementary science and mathematics portfolio developed by the Oregon New Standards Project. It is organized around the student goals for Oregon's

Certificate of Initial Mastery (CIM)—content areas (number sense, estimation, geography, measurement, statistics; patterns; physical, earth, space and life systems); and process skills (science as inquiry, problem solving, interpreting results; connections; and communication). The document includes a description of these areas, examples of items that could be selected for the portfolio that demonstrate student ability in these areas, entry cover sheets, and a self-review checklist. Students are responsible for assembling their own portfolios. The document also includes draft scoring guides and a letter of introduction. No technical information or sample student work is included.

(TC# 000.3STUPOQ)

Ostlund, Karen. ***Sizing Up Social Skills.*** **Located in: Science Scope 15, March 1992, pp. 31-33.**

The author presents a taxonomy of social skills important for the science classroom, provides a few ideas for how to teach them, and offers a couple of ideas on student and teacher monitoring techniques.

(TC#223.6SIZUPS)

O'Sullivan, Christine. ***The Cost of Performance Assessment in Science: The NAEP Perspective*****, 1995. Available from: National Assessment of Educational Progress, PO Box 6710, Princeton, NJ 08541, (800) 223-0267, (609) 734-1918, fax: (609) 734-1878.**

The author analyzes the cost of developing, administering, and scoring NAEP science hands-on tasks and compares it to the cost for multiple-choice items. She concludes that it takes about 23 percent more staff time for hands-on tasks than multiple-choice. Additionally, it costs $2 to $6 per hands-on kit.

TC# 600.6COSPEA)

Padian, Kevin. ***Improving Science Teaching: The Textbook Problem.*** **Located in: Skeptical Inquirer 17, Summer 1993, pp. 388-393.**

Although not strictly about assessment, this article is included because it discusses the nature of the tasks and activities that we give students to do. One of the major points of the article is that giving students "hands-on" activities doesn't ensure "good" activities. If we don't craft our tasks to get at the heart of what we want to accomplish with students, the tasks will be worthless both as instruction and assessment tools.

(TC#600.6IMPSCT)

Perlman, Carole. ***The CPS Performance Assessment Idea Book*, November 1994. Available from: Chicago Public Schools, 1819 W. Pershing Rd., Chicago, IL 60609.**

This handbook was developed to assist educators in developing performance assessments. Its most notable feature is a bank of over 90 sets of rubrics for assessing student performance in various grade levels and subject areas—reading, writing, mathematics, science, social studies, and fine arts. There are also well written sections on how to develop rubrics and performance tasks, and how to evaluate the quality of rubrics and performance tasks.

(TC# 000.3CPSPEA)

Pine, Jerry, Gail Baxter, and Richard J. Shavelson. ***Assessments for Hands-On Elementary Science Curricula*, 1991. Available from: Physics Department, California Institute of Technology, Pasadena, CA 91125, (818) 356-6811.**

The authors present the case that science curriculum should enable students to learn how to pursue an experimental inquiry, and should give them the ability to construct new knowledge from their observations. Assessment should match this, but the authors question whether it is *always* necessary to have hands-on assessment tasks. The authors designed a study that compared observer rating of fifth- and sixth-grade student performance of hands-on tasks with five other surrogates: ratings of student lab notebooks, a computer simulation, free-response paper and pencil questions, multiple-choice items, and California Test of Basic Skills (CTBS) scores. The surrogates (with the exception of the CTBS) were designed to parallel the hands-on tasks as closely as possible.

Results showed:

1. It was possible to get consistent ratings of student performance on hands-on tasks with trained observers

2. Ratings of lab notebooks were a promising surrogate for observations, but they have to be designed carefully

3. Computer simulations, open-ended questions, and multiple-choice questions were not good surrogates

4. CTBS scores were moderately related to hands-on performance, but appeared to mainly reflect general verbal and numerical skills

5. In order to assess inquiry instruction rather than general natural ability, hands-on tasks need to be carefully designed

The paper briefly describes all the tasks used in the study, but does not present them in enough detail to replicate. A companion paper, *New Technologies for Large-Scale Science*

Assessments: Instruments of Educational Reform (TC#600.3NEWTEF), describes the tasks in more detail.

(TC#600.3ASSFOH)

Pomeroy, Deborah. ***Implications of Teachers' Beliefs About the Nature of Science: Comparison of the Beliefs of Scientists, Secondary Science Teachers, and Elementary Science Teachers.*** **Located in: <u>Science Education</u> 77, June 1993, pp. 261-278.**

The author reports on a study that asked the question: "Are there differences between how scientists and teachers view the nature of science, scientific methodology, and related aspects of science education?" She developed a 50-item survey which covered: (1) the nature of scientific inquiry—is the only valid way of gaining scientific knowledge through inductive methods using controlled experimentation, or is there a role, as more contemporary views have it, for dreaming, intuition, play, and inexplicable leaps? (2) what K-12 science education should be like, and (3) background information on respondents. The complete survey and discussion of the results are included in the article.

(TC#600.4TEABEA)

Porter, Andrew C. ***Standard Setting and the Reform of High School Mathematics and Science*****, 1995. Available from: Wisconsin Center for Education Research, School of Education, University of Wisconsin-Madison, 1025 W. Johnson St., Madison, WI 53706, (608) 263-4200.**

The author reports on a study of the effects of increased enrollment in academic classes resulting from raising course-taking graduation requirements. Previous studies discovered that increased graduation requirements did not raise dropout rates and that, indeed, students were taking more academic classes, especially science and math. This study examined whether the affected academic courses were "watered down" to accommodate weaker and less motivated students. The author found that courses were not watered down. The conclusion is that standards for high school students have, indeed, been raised.

(TC# 000.6STASER)

Psychological Corporation, The. ***GOALS: A Performance-Based Measure of Achievement—Science*****, 1992. Available from: Psychological Corporation, Order Service Center, PO Box 839954, San Antonio, TX 78283, (800) 228-0752.**

GOALS is a series of open-response questions (only one right answer) that can be used alone or in conjunction with the MAT-7 and SAT-8. Three forms are available for 11 levels of the test covering grades 1-12 for each of science, math, social studies, language and reading. Each test (except language) has ten items. On the science test, tasks cover content from the biological, physical, and earth/space sciences. Each task seems to address the ability to use a discrete science process skill (e.g., draw a conclusion, record data) or use a piece of scientific information. The tasks require students to answer a question and then (usually) provide an explanation.

Responses are scored on a four-point holistic scale (0-3) which emphasizes the degree of correctness or plausibility of the response and the clarity of the explanation. A generalized scoring guide is applied to specific questions by illustrating what 3, 2, 1 and 0 responses look like. Both norm-referenced and criterion-referenced (how students look on specific concepts) score reports are available. Scoring can be done either by the publisher or locally. A full line of report types (individual, summary, etc.) are available. The materials we obtained did not furnish any technical information about the test itself.

(TC#610.3GOALSS)

Psychological Corporation, The. *Integrated Assessment System—Science Performance Assessment*, 1992. Available from: Psychological Corporation, Order Service Center, PO Box 839954, San Antonio, TX 78283, (800) 228-0752.

This is a series of seven tasks designed to be used with students in grades 2-8 (one task per grade level) The tasks involve designing and conducting an experiment based on a problem situation presented in the test. Students are provided various materials with which to work. Students may work individually or in teams, but all submitted products must be individually generated. Students generate a hypothesis they wish to test, write down (or show using pictures) the procedures used in the experiment, record data, and draw conclusions. At the end, students are asked to reflect on what they did and answer questions such as: "What problem did you try to solve?" "Tell why you think things worked the way they did," and "What have you seen or done that reminds you of what you have learned in the experiment?" The final question in the booklet asks students how they view science. This question is not scored but can be used to gain insight into students' performances.

Only the written product in the answer booklet is actually scored. (However, the publisher recommends that teachers watch the students as they conduct the experiment to obtain information about process. A checklist of things to watch for is provided.) Responses can be scored either holistically or analytically using general criteria. The holistic scale (0-6) focuses on an overall judgment of the performance based on quality of work, conceptual understanding, logical reasoning, and ability to communicate what was done. The four analytical traits are experimenting (ability to state a clear problem, and then design and carry out a good experiment), collecting data (precise and relevant observations), drawing conclusions (good conclusions supported by data), and communicating (use of appropriate scientific terms, and an understandable presentation of what was done.). Traits are scored on a scale of 1-4.

In the materials we obtained, there are no student performances provided to illustrate the scoring. No technical information about the assessment is included.

(TC#600.3INTASS)

Raizen, Senta and J. Kaser. ***Assessing Science Learning in Elementary School: Why, What, and How?*** **Located in: Phi Delta Kappan, May 1989, pp. 718-722.**

This paper describes some of the limitations of current standardized, multiple-choice tests to assess science, discusses how this combines with inadequate teacher preparation and textbooks to create inferior science instruction, and provides a list of questions to ask about any test being considered for use. The list of questions includes such things as "Are problems with more than one correct solution included?" and "Are there assessment exercises that encourage students to estimate their answers and to check their results?"

(TC#600.6ASSSCL)

Regional Educational Laboratory Network Program. ***Improving Science and Mathematics Education—A Database and Catalog of Alternative Assessments*****, 1994. Available from: Document Reproduction, Northwest Regional Educational Laboratory, 101 SW Main St., Suite 500, Portland, OR 97204, (503) 275-9519, fax (503) 275-9489.**

This database/catalog provides information about current efforts to redesign assessment to match changing goals for students and ideas about instruction. The database contains descriptive information on alternative assessments in science and mathematics that cover all grade levels, levels of assessment (classroom to national), and purposes. Developers include teachers, school districts, state departments of education, national governments, universities, and other research and development institutions. The most appropriate users are assessment specialists, curriculum coordinators, and others responsible for developing alternative assessments.

Note that the database contains only information about the assessments. Actual copies of the assessment instruments themselves are available from the contact people listed in the catalog. The database operates using FileMaker Pro software from Claris.

(TC# 000.1DATCAA2)

Regional Educational Laboratory Network Program. ***Improving Science and Mathematics Education—A Toolkit for Professional Developers: Alternative Assessment*, 1994. Available from: Document Reproduction, Northwest Regional Educational Laboratory, 101 SW Main St., Suite 500, Portland, OR 97204, (503) 275-9519, fax (503) 275-9489.**

The 552-page Toolkit was designed cooperatively by all 10 regional labs as a teacher professional development resource. It is a compilation of activities and supportive materials that serve both as an alternative assessment resource and a means of engaging teachers in dialogue about changing the way mathematics and science have traditionally been taught and assessed. The Toolkit contains:

- Information and professional development activities on the topics of: rationale for alternative assessment, integrating assessment and instruction, design options for alternative assessment, being a critical consumer of assessments, grading/reporting, and planning effective professional development
- Twenty-one sample assessments
- Bibliography of resources

(TC# 000.6TOOKIP2)

Riggs, Iris M. and Larry G. Enochs. ***Toward the Development of an Elementary Teacher's Science Teaching Efficacy Belief Instrument*, 1989. Available from: ERIC ED 308 068.**

This publication reports on a study in which the Personal Science Teaching Efficacy Belief Scale and the Science Teaching Outcome Expectancy Scale were administered to measure teacher feelings of self-efficacy and outcome expectancy. The authors present evidence that the combined instrument is valid for studying elementary teacher's beliefs toward science teaching and learning. The instrument is included.

(TC#600.4TOWDEE)

Riverside Publishing Company, The. ***Performance assessments for ITBS, TAP and ITED (various levels and subject areas)*, 1993. Available from: The Riverside Publishing Company, 8420 Bryn Mawr Ave., Chicago, IL 60631, (800) 323-9540.**

This is a series of open-response items in the areas of social studies, science, mathematics, and language arts. Nine levels are available for grades 1-12. They supplement achievement test batteries available from the publisher: ITBS, TAP, and ITED. Each level uses a scenario to generate a series of related questions, some of which have only one right answer, and others of which are more open-ended and generative.

For example, the science assessments we received center around designing a biology display for a local museum (high school) and exploring the web of life (elementary). The biology assessment has students design and use classification systems for living things, draw a bar graph based on presented information, generalize about muscles, and show knowledge about the brain. Tests take $1^1/_2$ to 2 hours depending on grade level.

No information about scoring, sample student performances, nor technical information was included in the materials we received. However, the publishers' catalog indicates that scoring materials are available and that the tests are normed.

(TC# 060.3PERAST)—IN-HOUSE USE ONLY

Roth, Wolff-Michael. *Dynamic Evaluation*. Located in: Science Scope 15, March 1992, pp. 37-40.

The author describes a method by which students plan and report experiments: the Vee Map. The Vee Map requires students to list vocabulary related to the topic they are reporting, develop a concept map of these terms, describe the experimental design, describe the data collected, and present their conclusions. One extended example in earth science is given. Performance criteria for assessing the Vee Map is sketchy. No technical information is included.

(TC#630.6DYNEVA)

Scottish Examination Board. *Standard Grade—Amended Arrangements in Biology*, 1992. Available from: Dr. David M. Elliot, Director of Assessment, Ironmills Rd., Dalkeith, Midlothian, Edinburgh, EH22 1LE, Scotland, UK, (031) 663-6601.

The Scottish Examination Board prepares end-of-course tests for a variety of high school subjects to certify level of student competence. We have received tests for math, general science, and biology. The course syllabus for biology calls for coverage of: the biosphere, the world of plants, animal survival, investigating cells, the body in action, inheritance, and biotechnology. The goals of the course are: knowledge and understanding, problem solving, practical abilities, and attitudes. (Only the first three are assessed.) There are two main parts to the assessment for biology—written tests (developed by the Examination Board) and classroom embedded performance assessments (conducted by teachers according to specifications developed by the Examination Board). The two parts are combined to rate student competence. Each goal is rated on a scale of 1-5, overall performance is rated on a scale of 1-7 (1 being highest).

The performance assessments cover techniques (students must demonstrate competence in ten areas such as "carrying out a test for starch") and investigations (students are scored for "generative skills," "experimentation skills," "evaluation skills," and "recording and reporting skills" on each of two investigations). Scoring entails assigning points for various specified features of performance, such as 2 points for "producing a table of results with suitable headings and units of measurement."

The package of materials we received included the course syllabus, specifications for the written and performance assessments, and copies of the written tests for 1993. It did not include technical information or sample student responses.

(TC# 640.3BIOSTG)

Scottish Examination Board. ***Standard Grade—Amended Arrangements in Science,*** **1992. Available from: Dr. David M. Elliot, Director of Assessment, Ironmills Rd., Dalkeith, Midlothian, Ediburgh, Scotland, EH22 1LE.**

The Scottish Examination Board prepares end-of-course tests for a variety of high school subjects to certify level of student competence. We have received tests for math, general science, and biology. The course syllabus for general science calls for coverage of: healthy and safe living, an introduction to materials, energy and its uses, and a study of environments. Goals are knowledge, problem solving, practical abilities (science process skills), and attitudes. (Only the first three are assessed.) There are two main parts to the assessment for general science—written tests (developed by the Examination Board) and classroom embedded performance assessments (conducted by teachers according to specifications developed by the Examination Board). The two parts are combined to rate student competence on a scale of 1-7. (Separate ratings are given overall and for each of the three goals.)

The performance assessments cover techniques (students must demonstrate competence in eight areas such as "measuring ph") and investigations (students are scored for "generative skills," "experimentation skills," "evaluation skills," and "recording and reporting skills" on each of two investigations). Scoring entails assigning points for various specified features of performance, such as 2 points for "clearly identifying the purpose of the investigation in terms of the relevant variables."

The package of materials we received included the course syllabus, specifications for the written and performance assessments, and copies of the written tests for 1993. It did not include technical information or sample student responses.

(TC# 610.3SCISTG)

Semple, Brian McLean. ***Performance Assessment: An International Experiment,*** **1991. Available from: Educational Testing Service, The Scottish Office, Education Department, Rosedale Rd., Princeton, NJ 08541, (609) 734-5686.**

Eight math and eight science tasks were given to a sample of thirteen-year-olds in five volunteer countries (Canada, England, Scotland, USSR, and Taiwan). This sample was drawn from the larger group involved in the main assessment. The purpose of the assessment was to provide an information base to participating countries to use as they saw fit, and to examine the use of performance assessments in the context of international studies.

The 16 hands-on tasks are arranged in two 8-station circuits. Students spend about five minutes at each station performing a short task. Most tasks are "atomistic" in nature; they measure one small skill For example, the 8 math tasks concentrate on measuring length, angles, and area, laying out a template on a piece of paper to maximize the number of shapes obtained, producing given figures from triangular cut-outs, etc. Some tasks require students to provide an explanation of what they did. All 16 tasks are included in this document, although some instructions are abbreviated and some diagrams are reduced in size. the complete tasks, administration and scoring guides are available from ETS.

Most scoring is right/wrong; student explanations are summarized by descriptive categories. There is also observation of the products of students' work.

Student summary statistics on each task are included. There is a brief summary of teacher reactions, student reactions, the relationship between student performance on various tasks, and the relationship between performance on the multiple-choice and performance portions of the test. A few sample student performances are included.

(For related information, see Nancy Mead, also listed in this bibliography.)

(TC# 600.3PERASS)

Semple, Brian McLean. ***Science—Assessment of Achievement Programme,*** **1992. Available from: Scottish Office Library, New St. Andrews House, Room 4/51a, Edinburgh, EH1 3SY, Scotland, UK, (031) 244-4388.**

The "Assessment of Achievement Programme (AAP)" was established by the Scottish Office of Education Department in 1981 to monitor the performance of pupils in grades 4, 7, and 9. This document reports on the 1990 science assessment. The assessment focused on science process skills: observing, measuring, handling information, using knowledge, using simple procedures, inferring, and investigating.

Assessment tasks used two formats: written (select the correct answer and provide a reason for the choice); and practical (use manipulatives to select the correct answer and provide a reason, or longer investigations such as observe an event and write down the observation). The practical portion was set up in (1) circuits of eight stations (four minutes at each station), or (2) longer investigations of 15-30 minutes. Detailed scoring guides are not provided in the materials we have. Student responses were apparently scored for both the correctness of the answer and the adequacy of the explanation.

The document we have describes the background of the assessment program, provides sample written and practical tasks for each skill area assessed, and describes student performance on the tasks (by grade level and gender, and over time). Neither technical information nor sample student performances are included.

(TC# 600.3SCAASA)

Serrano, Claudia. ***A Look at Portfolio Assessment in San Diego High School's Sophomore House*****, 1991. Available from: San Diego City Schools, 4100 Normal St., Room 3133, San Diego, CA 92103, (619) 298-8120.**

This paper describes an interdisciplinary (physics, math, and English) portfolio system for tenth graders that supports block scheduling in an inner city magnet school. Students keep a notebook of all work in each class. Class portfolios contain work selected from the notebook. Class portfolios are used as the basis for the culminating "House Portfolio" in which students select work to demonstrate that they have attained specified learning goals. The "House Portfolio" also includes written reflection and a final exhibition of mastery.

The document includes student instructions for assembling the portfolio, an entire student portfolio, instructions for a formal oral presentation of their portfolio, checklists and evaluation forms, and assistance with reflective writings and exit exhibitions. No technical information is included.

(TC# 000.3LOOPOA)

Shavelson, Richard J., Neil B. Carey, and Noreen M. Webb. ***Indicators of Science Achievement: Options for a Powerful Policy Instrument.*** **Located in: Phi Delta Kappan, May 1990, pp. 692-697.**

The authors review reasons for moving from multiple-choice tests of science achievement to more performance-based measures, and then discuss three examples: looking at how well students can move between different representation of a problem, mental models, and performance assessments/surrogates.

(TC#600.6INDOFS)

Shavelson, Richard J., Gail P. Baxter, Jerry Pine, and J. Yure. ***New Technologies for Large-Scale Science Assessments: Instruments of Educational Reform*****, 1991. Available from: University of California, 552 University Rd., Santa Barbara, CA 93106, (805) 893-8000.**

This document is a series of papers that report in more detail on the studies of hands-on versus surrogate assessment tasks also described in *Assessments for Hands-On Elementary Science Curricula* (TC#600.3ASSFOH). This includes more detailed descriptions of the three hands-on tasks (paper towels, sow bugs, and electric mysteries) and computer simulations. Findings, in addition to those reported in the companion paper, include:

1. Although observers could be trained to be very consistent in their ratings, a major source of error is still in the tasks chosen. That is, the decision about the level of an individual's performance depends greatly on the particular task used.

2. Hands-on assessment provides different information than that provided by paper and pencil tests.

For additional information to those reported in this paper and its companion paper see the following references:

Baxter, Gail P., Richard J. Shavelson, Susan Goldman, and Jerry Pine. *Evaluation of Procedure-Based Scoring for Hands-on Science Assessment.* Journal of Educational Measurement, 1992, 29, pp. 1-17. (TC#600.3EVAPRB)

Shavelson, Richard J., and Gail P. Baxter. *What We've Learned About Assessing Hands-On Science.* Located in: Educational Leadership, Vol. 49, No. 8, May 1992, pp. 20-25. (TC#600.3WHAWEL)

Shavelson, Richard J., Gail P. Baxter, and Jerry Pine. *Performance Assessments—Political Rhetoric and Measurement Reality.* Located in: Educational Researcher, Vol. 21, No. 4, May 1992, pp. 22-27. (TC#600.3PERASP)

Shavelson, Richard J., Maria Araceli Ruiz-Primo, Gail P. Baxter. *On the Stability of Performance Assessments.* Located in: Journal of Educational Measurement, Spring 1993, 30, pp 41-53 (TC#600.6ONSTAP)

(TC#600.3NEWTEF)

Small, Larry. *Science Process Evaluation Model*, 1992. Available from: Schaumburg Community Consolidated District #54, 524 E. Schaumburg Rd., Schaumburg, IL 60194, (708) 885-6700.

This document contains a paper presented at a national conference in 1988 which briefly describes Schaumburg's science assessment system, and a set of tests for students in grades 4-6. The tests have three parts: multiple-choice to measure content and some process skills, self-report survey to assess attitudes toward science, and hands-on tasks to assess science process skills.

The hands-on part attempts to measure 11 student science process skills: observing, communicating, classifying, using numbers, measuring, inferring, predicting, controlling variables, defining operationally, interpreting data, and experimenting. It consists of students using manipulatives to answer fixed questions such as "Which drop magnifies the most?" or "Which clay boat would hold the most weights and still float in the water?" Students respond by choosing an answer (multiple-choice), supplying a short answer, or, in a few cases, drawing a picture or graph. Complete tests for Grades 4, 5, and 6 are included.

No scoring procedures or technical information were included with the package. For additional information on this project see *Teamwork Testing* (Small—TC#650.3TEATES)

(TC#600.3SCIPRE)

Small, Larry, and Jane Petrek. *Teamwork Testing*. Located in: <u>Science Scope</u> 15, March 1992, pp. 29-30.

The authors describe a model for performance-based assessment in middle school chemistry which emphasizes group cooperation and the process of doing science. One task was described in detail. Performance criteria were hinted at, but not described. For other information on this project see *Science Process Evaluation Model* (Small—TC#600.3SCIPRE).

(TC#650.3TEATES)

Smist, Julianne M., Francis X. Archambault, and Steven V. Owen. *Gender Differences in Attitude Toward Science*, 1994. Available from: Julianne M. Smist, Biology/Chemistry Department, Springfield College, Springfield, MA 01109.

The authors report a study on how the *Test of Science-Related Attitudes* (TOSRA), developed in Australia, works with American high school students. The TOSRA has 70 questions that cover attitudes toward science, preference for experimentation, social implications of science, normality of scientists, attitude toward science classes, and openness to new ideas. The authors conclude that the TOSRA is a valid and reliable instrument for use with American students. TOSRA questions, and the subscales they relate to, are included, but need to be reformatted for use.

(TC# 600.3GENDIA)

Stage, Elizabeth K. *Assessment in Science: Return to the Good Old Days?* Located in: <u>The Clearing House</u> 68, March/April 1995, pp. 215-218.

The author describes past and current trends in science curriculum and instruction and the role of performance assessments and portfolios in documenting skill. The author then describes the New Standards Project plans for performance assessment in science and the rationale and questions to be addressed. No actual sample assessment tasks are included.

(TC# 600.6ASSSCR)

Stecher, Brian. ***The Cost of Performance Assessment in Science: The RAND Perspective*, 1995. Available from: RAND, 1700 Main St., PO Box 2138, Santa Monica, CA 90407.**

This paper describes a study of the costs of performance assessments in science. Tasks (1) used manipulatives, (2) took 30-55 minutes, (3) required the manipulation of scientific equipment or materials, and (4) resulted in paper and pencil responses. The analysis looked at costs for development, preparation of equipment, task administration, scoring, personnel time, travel, and other costs The authors concluded that such tests are about 100 times more expensive (± $30/student) than a standardized, multiple-choice test lasting 30 minutes, and 5-6 times more expensive than a typical direct writing assessment.

(TC# 600.6COSPER)

Stecher, Brian M. ***Describing Secondary Curriculum in Mathematics and Science: Current Status and Future Indicators*, 1992. Available from: RAND, 1700 Main St., PO Box 2138, Santa Monica, CA 90407.**

The author describes what could go into an indicator system of the health of science and mathematics education. He concludes that current data sources for these indicators are inadequate.

(TC#000.6DESSEC)

Surber, John R.. Map Tests (various documents). Available from: John R. Surber, Department of Educational Psychology, University of Wisconsin, Milwaukee, WI 53201, (414) 229-1122.

This is a collection of the following four documents:

Surber, John R. *Mapping as a Testing and Diagnostic Device*. Located in: C. D. Holley and D. F. Dansereau (Eds.), Spatial Learning Strategies, 1984, pp. 213-233. Available from: Academic Press, Inc., 1250 6th Ave., San Diego, CA 92101.

Surber, John R., Philip L. Smith. *Testing for Misunderstanding*. Located in Educational Psychologist 16, 1981, pp. 165-174.

Surber, John R., Philip L. Smith, and Frederika Harper. *Technical Report No. 1. Structural Maps of Text as a Learning Assessment Technique: Progress Report for Phase I* (undated).

Surber, John R., Philip L. Smith, and Frederika Harper. *Technical Report No. 6. The Relationship Between Map Tests and Multiple Choice Tests*, March 1982.

These reports describe the development of map tests as an assessment technique to identify conceptual misunderstandings that occur when students learn from text. In this testing technique, concepts and their interrelationships are represented graphically. These graphic representations are called text maps. A training manual for constructing text maps is included. The manual introduces the symbols to be used in the concept map to indicate: 1) definitions, 2) characteristics or properties, 3) examples, 4) temporal relations, 5) causal relations, 6) similarity, and 7) greater- or less-than comparisons.

The papers present four methods of using maps to assess the structure of student knowledge. All involve various levels of deleting information from a completed text map and providing clues on content and structure. Students complete the missing information—similar to a cloze test. Text maps and map tests can be constructed using any content area—science, social studies, etc. They can be used in study skills or reading classes. In these reports, the content of the training manual is drawn from chemistry and study skills.

(TC#150.6MAPTES)

Tamir, Pinchas. ***Various articles.*** **Available from: School of Education and Israel Science Teaching Center, Hebrew University, Jerusalem, Israel.**

This document includes several papers by the author that describe his work on "practical exams" in high school biology. Included are:

1. Discussion of the importance of such exams

2. Examples of the various of the tasks and associated performance criteria. Some performance criteria are task specific and some are general

3. A listing of 21 skills, knowledge, and behaviors that can be measured through practical exams

(TC# 600.3FOCSTA)

Vargas, Elena Maldonado and Hector Joel Alvarez. ***Mapping Out Students' Abilities.*** **Located in: Science Scope 15, March 1992, pp. 41-43.**

The authors use concept maps to assess the knowledge structures students have on various concepts in science. They give some brief help on how to design a concept map, and more extensive help on how to score maps. Two examples are given: matter and photosynthesis. (See also John Surber, TC# 150.6MAPTES)

(TC#600.6MAPOUS)

Whetton, Chris, Marian Sainsbury, Steve Hopkins, et al. *National Assessment in England and Wales*, 1992. Available from: National Foundation for Educational Research (NFER), The Mere, Upton Park, Slough, Berks, S11 2DQ, England, UK.

This document is a series of papers presented at the American Educational Research Association meeting in 1992. For additional information see Harlen (TC#600.6PERTES).

The papers review the history of the assessment, describe and present a few examples of the assessment tasks for seven-year-olds, discuss the support needed to assist teachers to administer this large a number of performance tasks, describe the changes that resulted for the 1992 assessment, and briefly describe plans for the 14-year-old assessment.

(TC#600.6NATASE)

Wiggins, Grant. *The Futility of Trying to Teach Everything of Importance*. Located in: <u>Educational Leadership</u>, November 1989, pp. 44-48, 57-59.

Assessment has to reflect what we value. This article presents a philosophy for science instruction that has implications for assessment. Specifically, the author maintains that the goal of education should not be to teach every fact that we think students will need to know, because this will be impossible to do. Rather, we should concentrate on developing those habits of mind and high standards of craftsmanship that will enable students to be lifelong learners and critical thinkers. The article briefly mentions some of the implications for assessment of this philosophy.

(TC#600.6FUTTRT)

Windham. K. *Brochures on Nuclear Chemistry*, circa 1991. Available from: Greensboro Day School, PO Box 26805, Greensboro, NC 27429, (910) 288-8590.

Students in a high school chemistry class are asked to prepare a brochure to help seventh graders in their study of the environmental impact of nuclear chemistry. Students prepare a one-page, tri-fold brochure on a very specific, part of nuclear chemistry. Topics could include plutonium storage, dismantling nuclear bombs, low- and high-level nuclear waste, problems at nuclear plants, radioactive isotopes as tracers, or radioactive elements in the environment. The brochure must include a resource list for the seventh graders.

Through developing the brochure, students are to: (1) display competence in using standard reference sources, (2) display thorough knowledge of a specific area in the field, and (3) display basic competence with word processing/pagemaker programs or other advanced technologies. The brochure is assessed on content and presentation (the scoring guide is somewhat sketchy). A one-page direction sheet for students is available. The materials we have include several sample student brochures, but no technical information.

(TC# 600.3BRONUC)

Yager, Robert E. and Alan J. McCormack. ***Assessing Teaching/Learning Successes in Multiple Domains of Science and Science Education.*** **Located in:** **Science Education 73, 1989, pp. 45-58.**

This article describes the authors' view of the proper targets for instruction in science (knowing and understanding, exploring and discovering, imagining and creating, feeling and valuing, and using and applying), goes on to describe the STS (Science-Technology-Society) approach to teaching science, and then lists some tests (mostly multiple-choice) that attempt to measure the targets. The paper is included on this bibliography mainly for the first two points.

(TC#600.5ASSTEL)

Yee, Gary, and Michael Kirst. ***Lessons from the New Science Curriculum of the 1950s and 1960s.*** **Located in:** **Education and Urban Society 26, February 1994, pp. 158-171.**

The title of this article says it all—what we need to do differently in the current round of content standards to avoid the problems of the past.

(TC# 600.5LESFRN)

Science Bibliography

Index Codes

A—Type

1 = Example
2 = Theory/how to assess/rationale for alternative assessment
3 = Content/what should be assessed
4 = Related: general assessment; program evaluation; results of studies; technology; attitudes

B—Purpose for the Assessment

1 = Large scale
2 = Classroom
3 = Research

C—Grade Levels

1 = Pre K-K
2 = 1=3
3 = 4-6
4 = 7-9
5 = 10-12
6 = Adult
7 = Special education
8 = All
9 = Other

D—Content Covered

1 = General science
2 = Biology
3 = Chemistry
4 = Physics
5 = Earth/Space Science
6 = Other
7 = All/Any

E—Type of Tasks

1 = Enhanced multiple choice
2 = Constructed response: short answers
3 = Long response/essay
4 = On-demand
5 = Project
6 = Portfolio
7 = Group
8 = Other than written
9 = Cognitive map

F—Skills Assessed

1 = Knowledge/conceptual understanding
2 = Application of concepts
3 = Persuasion
4 = Critical thinking/problem solving; reasoning/decision making
5 = Group process skills
6 = Quality of writing/communication
7 = Student self-reflection
8 = Process
9 = Comprehension

G—Type of Scoring

1 = Task specific
2 = General
3 = Holistic
4 = Analytical Trait

DOE=Dept. of Education

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C5Tamir (TC#600.3FOCSTA)
C5Windham (TC#600.3BRONUC)

C8Appalachia Ed. Lab. (TC#600.3ALTASM)
C8CA Assm. Coll. (TC#150.6CHACOU)
C8CA DOE (TC#600.6SCIASS)
C8Collins (TC#600.6PORSCE)
C8CTB/McGraw-Hill (TC#060.3CAT5PA)
C8Curriculum Corp. (TC#600.3SCICUA)
C8Curriculum Corp. (TC#600.3TECCUA)
C8Ed. Testing Service (TC#000.3MISALA)
C8Everett (TC#600.3PERASW2)
C8Gong (TC#600.6INSASL)
C8Hardy (TC#600.3OPTSCP)
C8IL Sci. Tchrs. Assn. (TC#600.3SCIPAH)
C8NAEP (TC#050.6LEABYD)
C8OR New Stand. Proj. (TC#000.3STUPOQ)
C8Perlman (TC#000.3CPSPEA)
C8Psychological Corp. (TC#610.3GOALSS)
C8Reg. Ed. Lab. Net. Prog. (TC#000.6TOOKIP2)
C8Riverside Publishing Co.(TC#060.3PERAST)
C8Riverside Publishing Co.(TC#500.3CALPRL)
C8Roth (TC#630.6DYNEVA)
C8Surber (TC#150.6MAPTES)
C8Vargas (TC#600.6MAPOUS)

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D1Appalachia Ed. Lab. (TC#600.3ALTASM)
D1CA DOE (TC#600.3SCINED)
D1Clarridge (TC#150.6IMPNEE)
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D1Green (TC#600.3PERBAA)
D1Hall (TC#600.3PERAST)
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D1Jones (TC#600.6SCIREC2)
D1Jones (TC#500.6PERBAS)
D1Kamen (TC#600.6USECRD)
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D1Small (TC#600.3SCIPRE)
D1Whetton (TC#070.3STAAST)
D1Whetton (TC#600.6NATASE)

D2Aurora Pub. Schools (TC#000.3SCIMAP)
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D2Gayford (TC#600.3CONTOM)

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D2Jones (TC#600.6SCIREC2)
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D2KY DOE (TC#060.3KIRIS94)
D2Lock (TC#600.6GENPRS)
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D5Lee (TC#620.3DISPRS)
D5Small (TC#650.3TEATES)

D6Curriculum Corp. (TC#600.3TECCUA)
D6Jones (TC#600.6SCIREC2)

D7Berenson (TC#600.6WRIOPE)
D7CA DOE (TC#600.6SCIASS)
D7Collins (TC#600.6PORSCE)
D7Comfort (TC#600.3SAMSCA
D7Ed. Testing Service (TC#000.3MISALA)
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D7Germann (TC#210.3DEVATT)
D7Gong (TC#600.6INSASL)
D7Hall (TC#600.3JUSDOI)
D7Meng (TC#600.6IMPINL)
D7NAEP (TC#050.6LEABYD)
D7OR New Stand. Proj. (TC#000.3STUPOQ)
D7Pine (TC#600.3ASSFOH)
D7Reg. Ed. Lab. Net. Prog. (TC#000.6TOOKIP2)
D7Shavelson (TC#600.3NEWTEF)
D7Smist (TC#600.3GENDIA)
D7Surber (TC#150.6MAPTES)
D7Vargas (TC#600.6MAPOUS)

D8CA DOE (TC#600.6SCIASS)

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E1Jones (TC#600.6SCIREC2)
E1Meng (TC#600.6IMPINL)
E1Semple (TC#600.3SCAASA)

E2Abraham (TC#650.3UNDMIE)
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E2Comfort (TC#600.3SAMSCA
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E3Alberta Education (TC#600.3EVASTL)
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F4Alberta Education (TC#600.3EVASTL)
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F4CTB/McGraw-Hill (TC#060.3CAT5PA)
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F4Everett (TC#600.3PERASW2)
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F4Hall (TC#600.3PERAST)
F4Hein (TC#600.6ACTASA)
F4Jones (TC#600.6SCIREC2)
F4Kanis (TC#600.3NINGRL)
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F4Martinello (TC#600.3MAROPS)
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F4Meng (TC#600.6IMPINL)
F4O'Rafferty (TC#600.3DESANP)
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F4Tamir (TC#600.3FOCSTA)

F5Alberta Education (TC#600.3EVASTL)
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F5Bennett (TC#600.3ASSTEVv)
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F6Comfort (TC#600.3SAMSCA
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F6Hall (TC#600.3PERAST)
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F6Macdonald Educational (TC#600.6WITOBM)
F6MD Assm. Consort. (TC#000.3PERAST)
F6MD DOE (TC#600.3MSPAPS)
F6Psychological Corp. (TC#600.3INTASS)
F6Reg. Ed. Lab. Net. Prog. (TC#000.6TOOKIP2)
F6Scottish Exam. Board (TC#640.3BIOSTG)
F6Windham (TC#600.3BRONUC)

F7Alberta Education (TC#600.3EVASTL)
F7CA DOE (TC#600.6SCIASS)
F7Reg. Ed. Lab. Net. Prog. (TC#000.6TOOKIP2)
F7Scottish Exam. (TC#610.3SCISTG)

F8Alberta Education (TC#600.3EVASTL)
F8CA DOE (TC#600.3GOLSTB)
F8CA DOE (TC#600.3SCINED)
F8CA DOE (TC#600.3GOLSTE2)
F8CA DOE (TC#600.6SCIASS)
F8Comfort (TC#600.3SAMSCA
F8CT DOE (TC#000.3CONCOC)
F8CTB/McGraw-Hill (TC#060.3CAT5PA)
F8Curriculum Corporation (TC#600.3SCICUA)

F8Curriculum Corporation (TC#600.3TECCUA)
F8Doran (TC#600.3ASSLAS)
F8Ed. Testing Service (TC#000.3MISALA)
F8Everett (TC#600.3PERASW2)
F8Green (TC#600 3PERBAA)
F8Hein (TC#600 6ACTASA)
F8IL Sci. Tchrs. Assn. (TC#600 3SCIPAH)
F8Kanis (TC#600 3NINGRL)
F8KY DOE (TC#600.3PEREVG)
F8Lawrence (TC#000.6INTUTCv)
F8Lawrence (TC#600 3UTACOC)
F8Macdonald Educational (TC#600 6LEATHS)
F8Macdonald Educational (TC#600.6WITOBM)
F8Martinello (TC#600 3MAROPS)
F8MD Assm. Consort. (TC#000.3PERAST)
F8MD DOE (TC#600.3MSPAPS)
F8Meng (TC#600 6IMPINL)
F8O'Rafferty (TC#600.3DESANP)
F8OR New Stand. Proj. (TC#000.3STUPOQ)
F8Psychological Corp. (TC#600.3INTASS)
F8Psychological Corp. (TC#610.3GOALSS)
F8Reg. Ed. Lab. Net. Prog. (TC#000.6TOOKIP2)
F8Scottish Exam. Board (TC#610.3SCISTG)
F8Scottish Exam. Board (TC#640.3BIOSTG)
F8Semple (TC#600.3SCAASA)
F8Small (TC#600.3SCIPRE)
F8Small (TC#650.3TEATES)
F8Tamir (TC#600.3FOCSTA)

F9CA DOE (TC#600.3GOLSTB)
F9CA DOE (TC#600.3GOLSTE2)
F9Curriculum Corporation (TC#600.3SCICUA)
F9KY DOE (TC#600.3PEREVG)
F9Reg. Ed. Lab. Net. Prog. (TC#000.6TOOKIP2)

F10Curriculum Corp. (TC#600.3SCICUA)
F10Curriculum Corp. (TC#600.3TECCUA)
F10Macdonald Educational (TC#600.6LEATHS)
F10Macdonald Educational (TC#600.6WITOBM)
F10Psychological Corp. (TC#600.3INTASS)

G1Appalachia Ed. Lab. (TC#600.3ALTASM)
G1Aurora Public Schools (TC#000.3SCIMAP)
G1CA DOE (TC#600.3GOLSTB)
G1CA DOE (TC#600.3SCINED)
G1CA DOE (TC#600.3GOLSTE2)
G1CA DOE (TC#600.6SCIASS)
G1Comfort (TC#600.3SAMSCA
G1CTB/McGraw-Hill (TC#060.3CAT5PA)
G1Ed. Testing Service (TC#000.3MISALA)
G1Gayford (TC#600.3CONTOM)
G1Hardy (TC#600.3OPTSCP)
G1Hein (TC#600.6ACTASA)
G1IL Sci. Tchrs. Assn. (TC#600.3SCIPAH)
G1Jones (TC#600.6SCIREC2)
G1Kamen (TC#600.6USECRD)
G1Kanis (TC#600.3NINGRL)
G1KY DOE (TC#600.3PEREVG)
G1KY DOE (TC#060 3KIRIS94)
G1Lawrence Hall of Science (TC#660 3FOSSWM)
G1Lawrence (TC#000.6INTUTCv)
G1Lawrence (TC#600.3UTACOC)
G1Lee (TC#620.3DISPRS)
G1Lock (TC#600.6GENPRS)
G1MD Assm. Consort. (TC#000.3MARASC)
G1MD Assm. Consort. (TC#000.3PERAST)
G1MD DOE (TC#600.3MSPAPS)
G1Meng (TC#600.6IMPINL)
G1O'Rafferty (TC#600.3DESANP)
G1Psychological Corp. (TC#610.3GOALSS)
G1Reg. Ed. Lab. Net. Prog. (TC#000.6TOOKIP2)
G1Scottish Exam. Board (TC#640.3BIOSTG)
G1Small (TC#600.3SCIPRE)
G1Small (TC#650.3TEATES)
G1Surber (TC#150.6MAPTES)
G1Tamir (TC#600.3FOCSTA)
G1Vargas (TC#600.6MAPOUS)
G1Whetton (TC#070.3STAAST)
G1Whetton (TC#600.6NATASE)

G2Abraham (TC#650.3UNDMIE)
G2Alberta Education (TC#600.3EVASTL)
G2Baker (TC#000.3CREPEA)
G2Bennett (TC#600.6ASSTEVh)
G2Bennett (TC#600.3ASSTEVv)
G2CA DOE (TC#600.3GOLSTB)
G2CA DOE (TC#600.3SCINED)
G2CA DOE (TC#600.3GOLSTE2)
G2CA DOE (TC#600.6SCIASS)
G2Doran (TC#600.3ASSLAS)
G2Ed. Testing Service (TC#000.3MISALA)
G2Everett (TC#600.3PERASW2)
G2Gayford (TC#600.3CONTOM)
G2Green (TC#600.3PERBAA)
G2Hall (TC#600.3PERAST)
G2Hein (TC#600.6ACTASA)
G2IL Sci. Tchrs. Assn. (TC#600.3SCIPAH)
G2KY DOE (TC#600.3PEREVG)
G2Macdonald Educational (TC#600.6LEATHS)
G2Macdonald Educational (TC#600.6WITOBM)
G2MD Assm. Consort. (TC#000.3MARASC)
G2Meng (TC#600.6IMPINL)
G2OR New Stand. Proj. (TC#000.3STUPOQ)
G2Perlman (TC#000.3CPSPEA)
G2Psychological Corp. (TC#600.3INTASS)
G2Reg. Ed. Lab. Net. Prog. (TC#000.6TOOKIP2)
G2Scottish Exam. Board (TC#610.3SCISTG)
G2Scottish Exam. Board (TC#640.3BIOSTG)

G2Tamir (TC=600.3FOCSTA)

G3CA DOE (TC=600.3GOLSTB)
G3CA DOE (TC=600.3SCINED)
G3CA DOE (TC=600.3GOLSTE2)
G3Ed. Testing Service (TC=000.3MISALA)
G3Everett (TC=600.3PFRASW2)
G3Gayford (TC=600.3CONTOM)
G3Green (TC=600.3PERBAA)
G3IL Sci. Tchrs. Assn. (TC=600.3SCIPAH)
G3KY DOE (TC=600.3PEREVG)
G3Meng (TC=600.6IMPINL)
G3Perlman (TC=000.3CPSPEA)
G3Reg. Ed. Lab. Net. Prog. (TC=000.6TOOKIP2)
G3Scottish Exam. Board (TC=640.3BIOSTG)

G4Alberta Education (TC=600.3EVASTL)
G4Baker (TC=000.3CREPEA)
G4Bennett (TC=600.6ASSTEVh)
G4Bennett (TC=600.3ASSTEVv)
G4Clarridge (TC=150.6IMPNEE)
G4Curriculum Corporation (TC=600.3SCICUA)
G4Curriculum Corporation (TC=600.3TECCUA)
G4Doran (TC=600.3ASSLAS)
G4Ed. Testing Service (TC=000.3MISALA)
G4Ft. Hays Ed. Dev. Center (TC=600.3SCIRUT)
G4Gayford (TC=600.3CONTOM)
G4Hall (TC=600.3JUSDOI)
G4Hall (TC=600.3PERAST)
G4IL Sci. Tchrs. Assn. (TC=600.3SCIPAH)
G4Meng (TC=600.6IMPINL)
G4OR New Stand. Proj. (TC=000.3STUPOQ)
G4Perlman (TC=000.3CPSPEA)
G4Psychological Corp. (TC=600.3INTASS)
G4Reg. Ed. Lab. Net. Prog. (TC=000.6TOOKIP2)
G4Scottish Exam. Board (TC=610.3SCISTG)
G4Scottish Exam. Board (TC=640.3BIOSTG)
G4Windham (TC=600.3BRONUC)